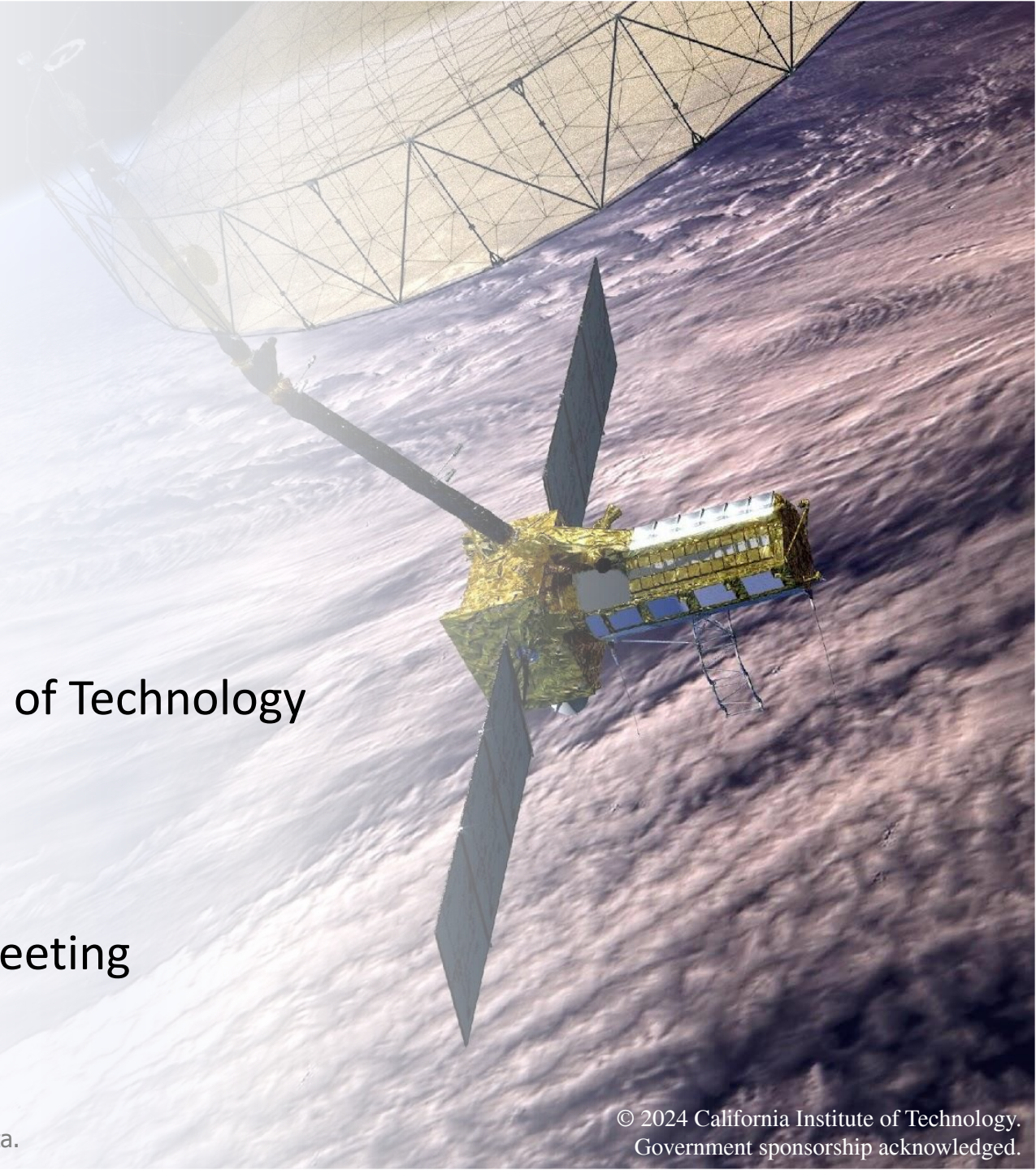
Monitoring Earth's Surface Water with the Upcoming NISAR Mission



Brandi Downs

Jet Propulsion Laboratory, California Institute of Technology

NISAR Cal/Val Team, Ecosystems Team

Western Water Applications Office Annual Meeting

April 29 – May 2, 2024

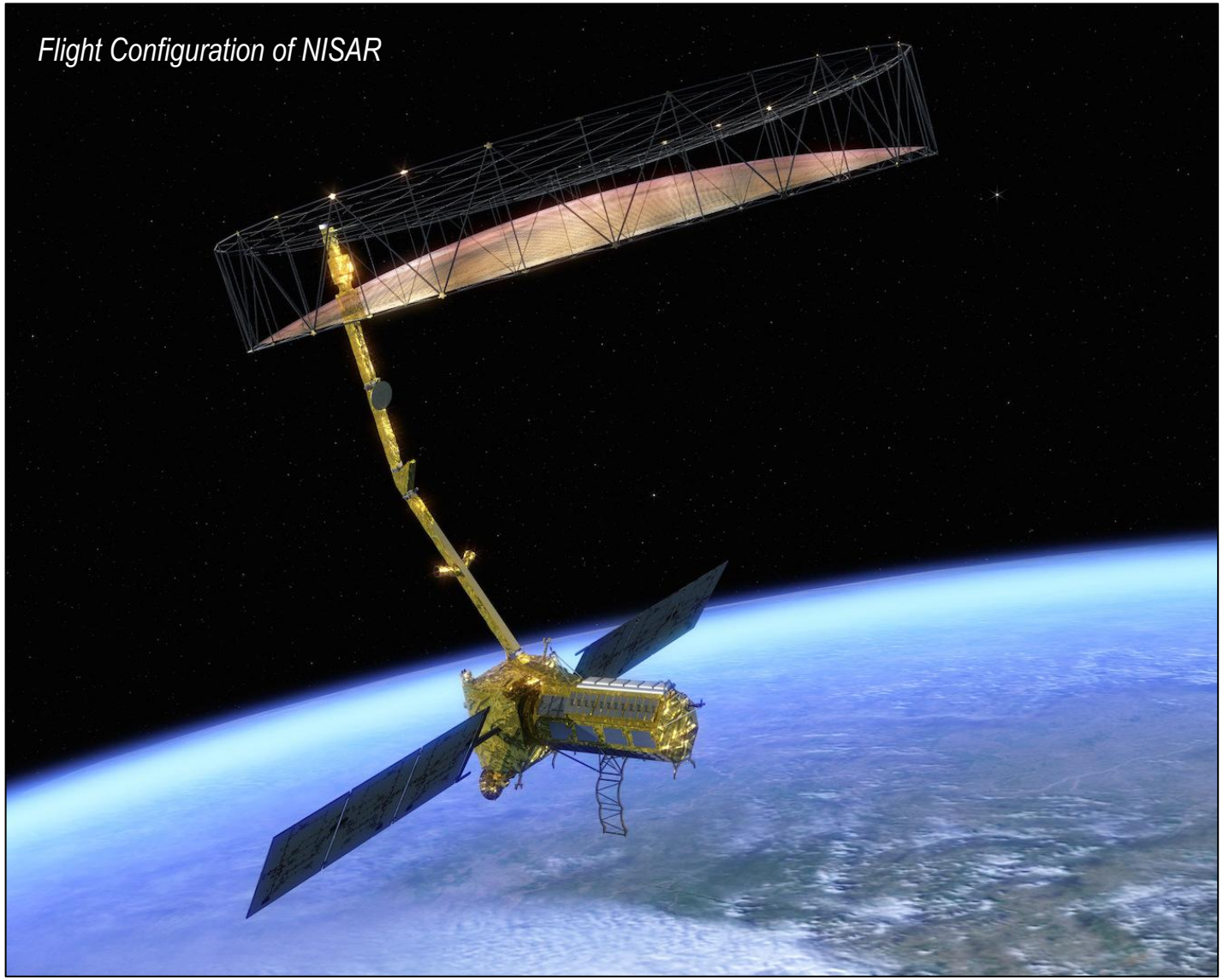
Solid Earth, **Ecosystems**, **Cryosphere**
Science and Applications Mission

NISAR – NASA ISRO SAR Mission

- **Collaboration of NASA and the Indian Space Research Organization (ISRO)**
- **Launch in 2024**
- **Two synthetic aperture radars (SAR)**
  - L-band (24 cm) global land + sea ice
  - S-band (10 cm) India's AOIs
- **Data will be free and open to all**
  - Hosted at the Alaska Satellite Facility Distributed Active Archive Center (DAAC)

Gerald Bawden
NASA Program Scientist

Paul Rosen
Project Scientist

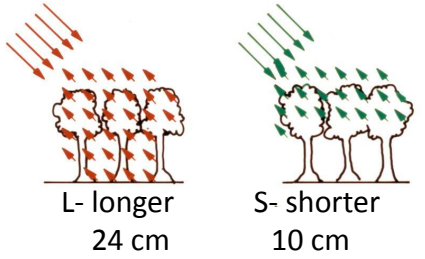


Solid Earth, **Ecosystems**, **Cryosphere**
Science and Applications Mission

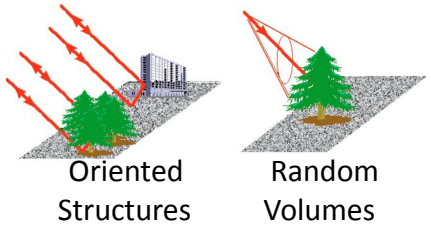
NISAR Instrument Characteristics

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

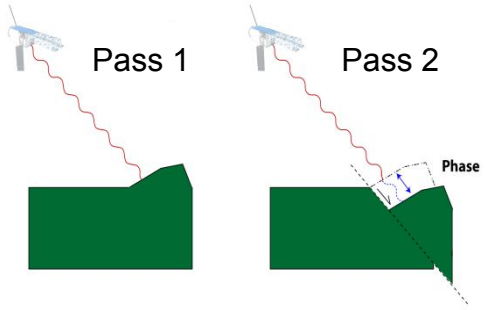
L- and S-band Wavelength



Polarimetry

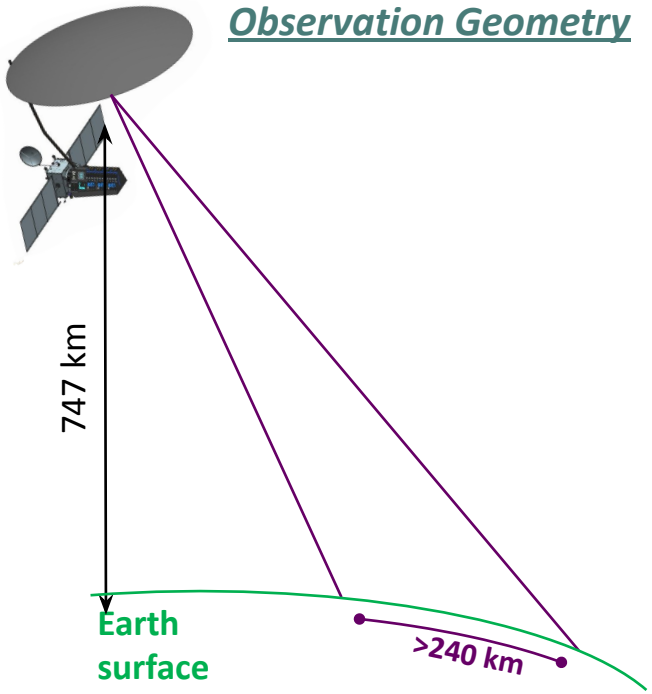


Repeat Pass InSAR

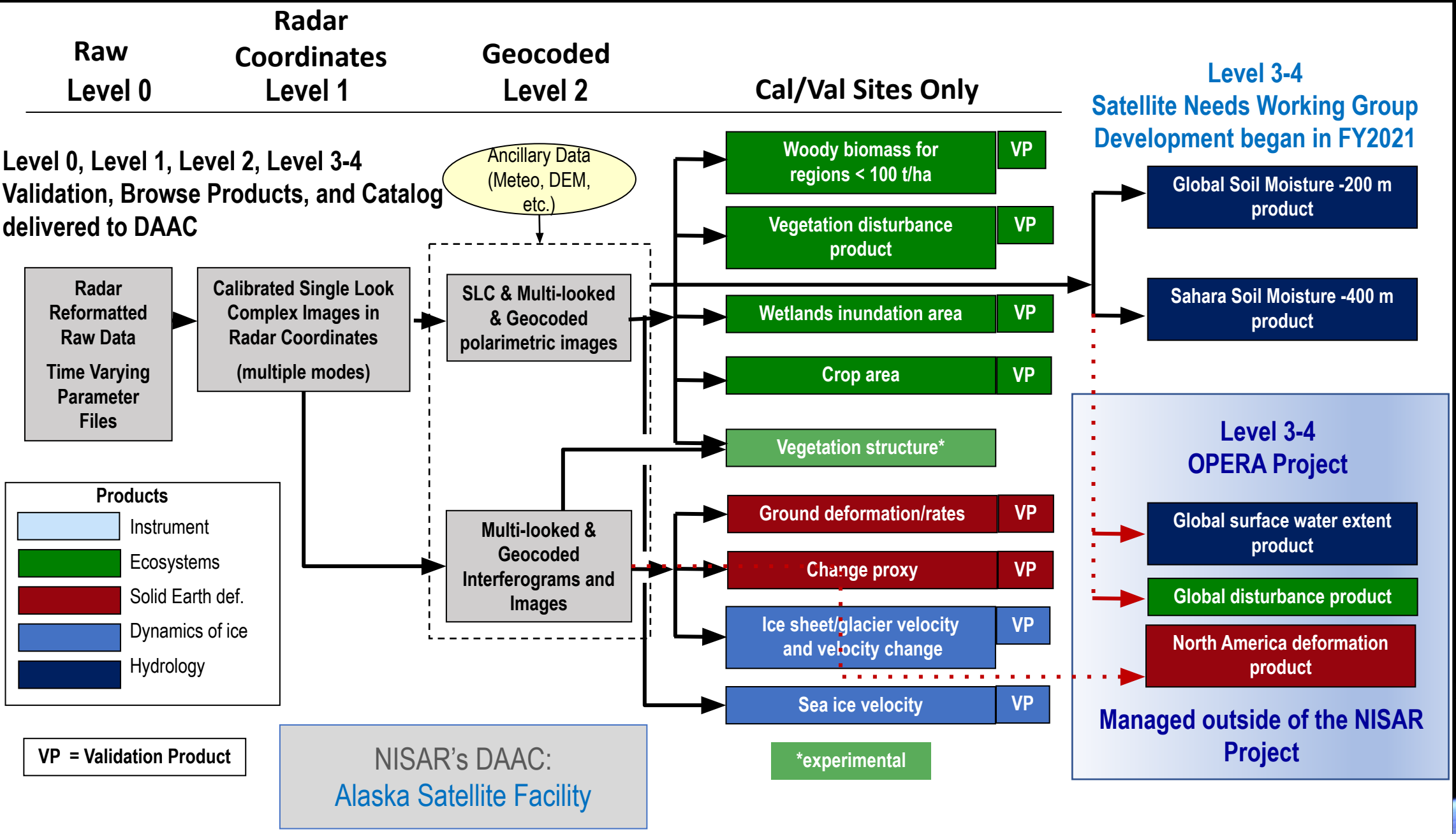


6 AM / 6 PM Orbit
98.5° inclination
Arctic Polar Hole: 77.5 Lat
Antarctic Polar Hole: -87.5 Lat

Observation Geometry

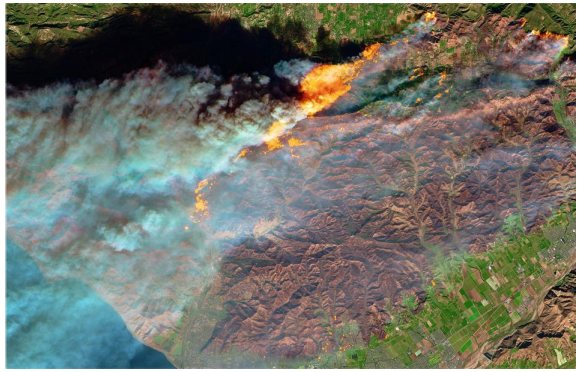


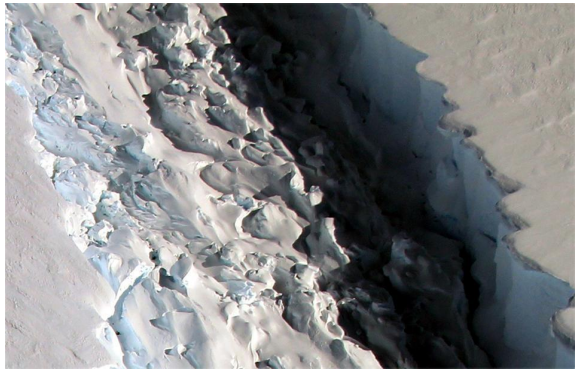
NISAR Science Data Products



NASA has thirteen level-2 science measurement requirements for NISAR

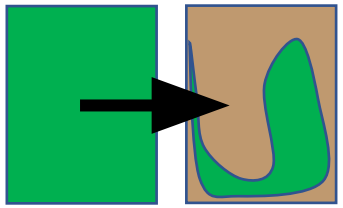
- NISAR will produce Level 2/3 science measurement products over Cal/Val sites to validate NISAR measurement requirements
  - Algorithms for producing the level-3 products may have parameters that must be calibrated as well.
- NISAR is also supporting the production of a global soil moisture product, produced for every collected image over land.
- NISAR must also demonstrate the capability to change the observation plan and achieve reduced processing latency for urgent response.





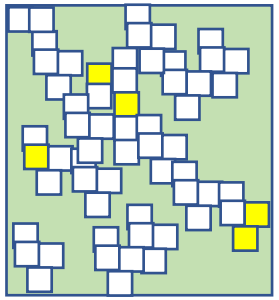

Ecosystem Measurement Requirements

Detection of Forest disturbance



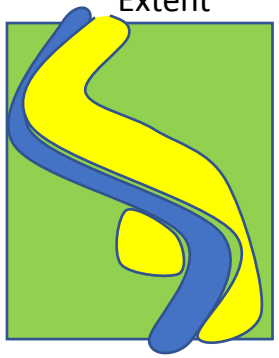
Accuracy: 80% for disturbances > 50%
at ha scale **annually**

Active agricultural
crop area



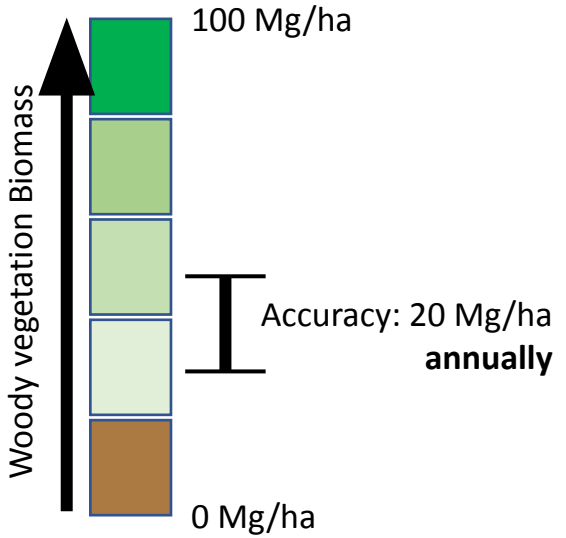
Accuracy: 80% at 1 ha resolution
every 3 months

Wetland inundation
Extent



Accuracy: 80% at 1 ha resolution
every 12 days

Biomass



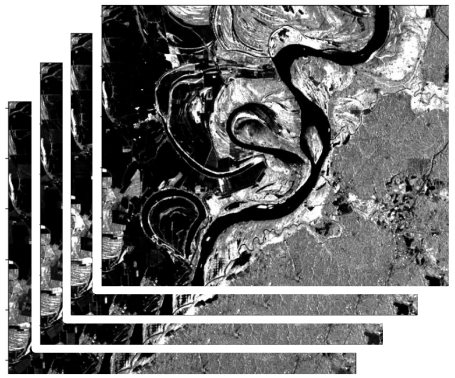
Over 1 hectare

Validated with field measurements and/or other remote sensing data

slide courtesy Bruce Chapman

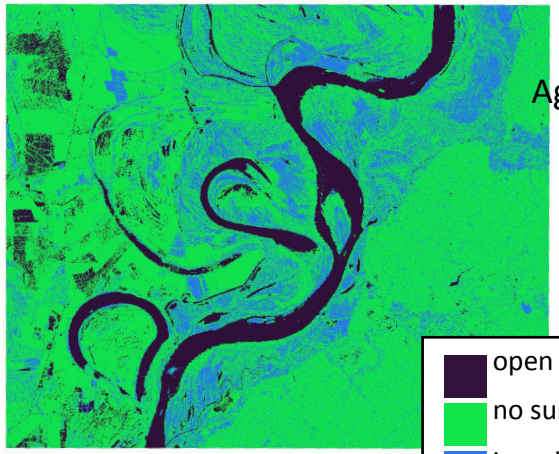
Wetland Inundation Classification

Time series stack of HH and HV NISAR data



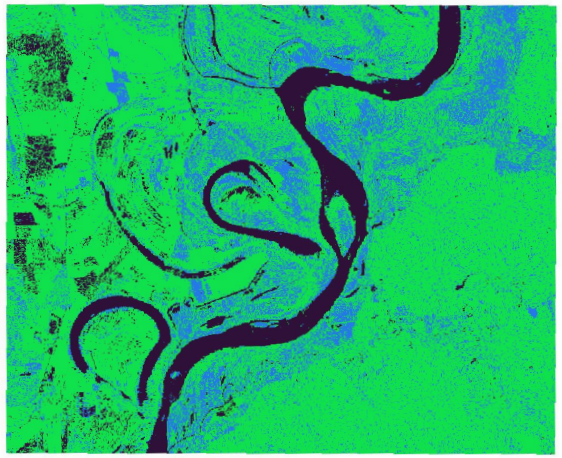
Classify based on thresholds on HH, HV, product, and ratio

Classified NISAR data



Aggregate to 1-ha resolution, co-register, and subset

1-ha NISAR Product



Wetland inundation Jupyter notebook on github:

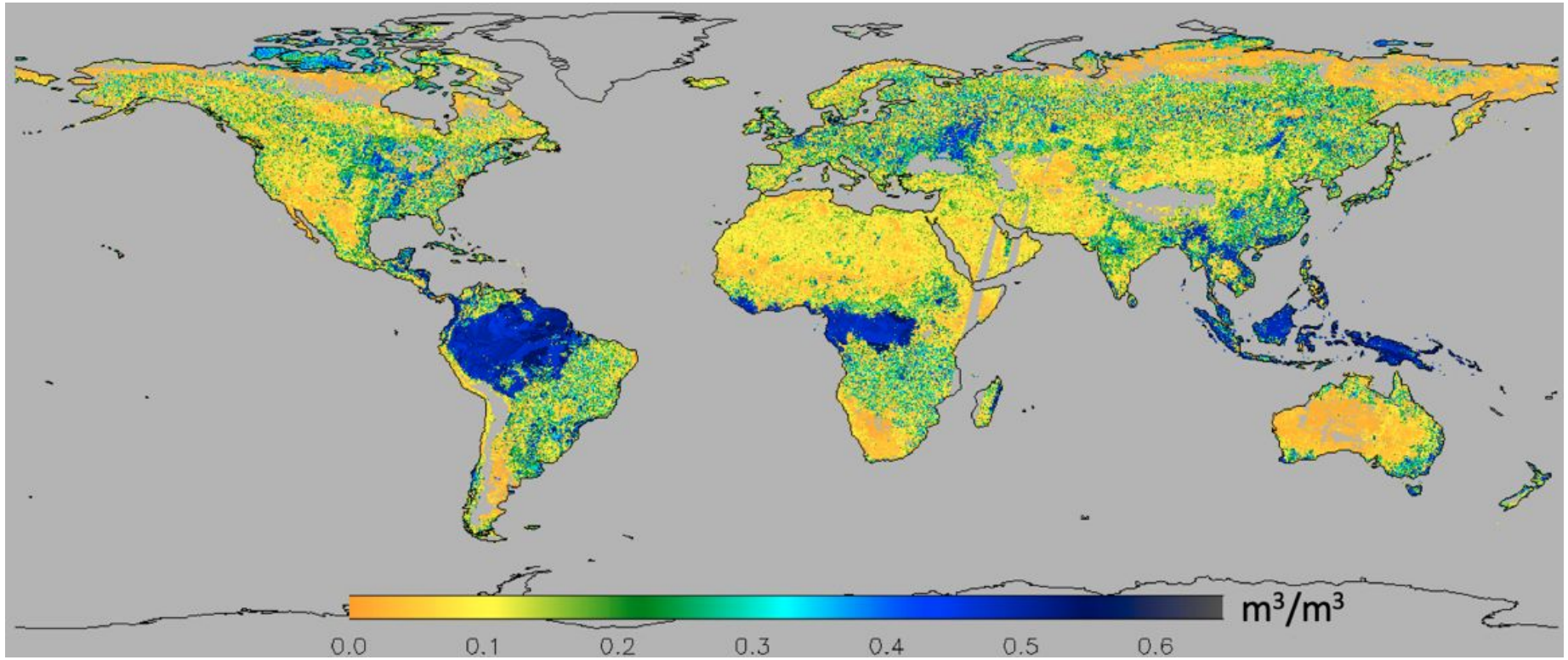
ALL the NISAR discipline-specific science algorithms on github:

Water: Vital for Life and Civilization

Water is critical to life on Earth, as excess water can lead to flooding, and water shortage causes drought. NISAR will provide maps of surface soil moisture globally every 6 to 12 days at the spatial scale of individual farm fields. This offers unprecedented detail and is vital for monitoring the habitats of plants, animals and humans.

Global map of surface soil moisture imaged by the radar onboard NASA's Soil Moisture Active Passive satellite (SMAP) at 3-km spacing over an 8-day period in May, 2015. [Kim et al., TGRS, 2017]

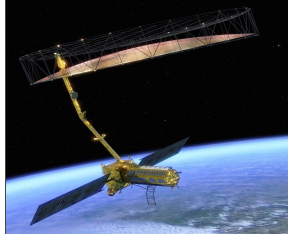
Photos (top-to-bottom): USGS, USDA,Wikimedia, NOAA, USGS



slide courtesy Cathleen Jones

nisar.jpl.nasa.gov

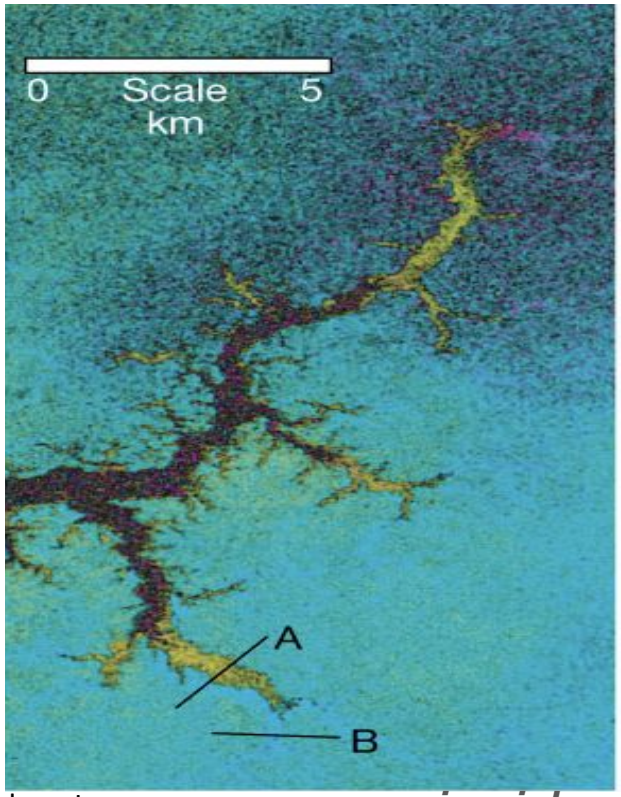
NASA-ISRO Synthetic Aperture Radar (NISAR) Mission

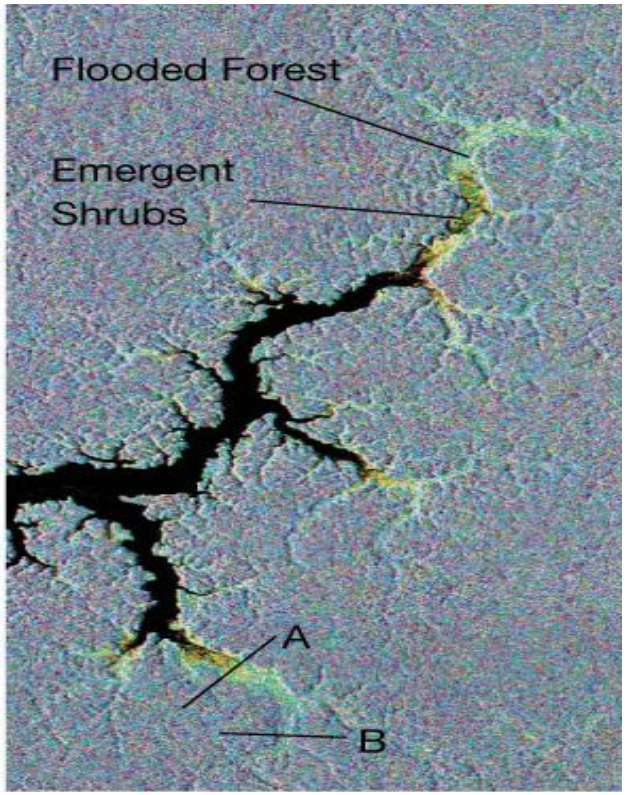


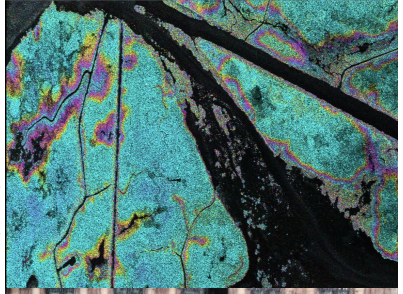
Flood Forecasting

Flood forecasting informs downstream communities if a flood is coming and how much flooding to expect. Like a virtual stream gauge, synthetic aperture radar is able to measure changing water levels in standing vegetation as flood waters from heavy upriver rains head downstream.

"Change in water level" products in flooded, vegetated areas were first demonstrated by the NASA SIR-C Synthetic Aperture Radar. In this image, centimeter-level changes in water level were measured over the Purus River in Brazil from two observations acquired 24 hours apart. (Alsdorf et al., Nature, 2000). Colors indicate how much the water level changed between the two observations. Between transects A & B there is 1-5 cm change in water level.







Photos (top-to-bottom): UAVSAR image NASA/JPL, Genaro Servin (Pexels), Pixabay, Pexels (4-5)

slide courtesy Cathleen Jones

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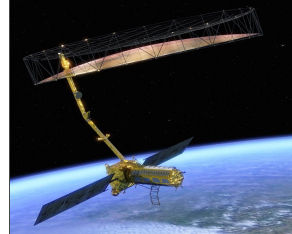
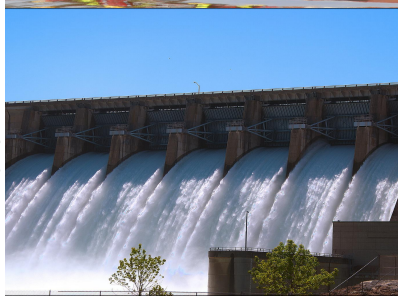
NASA-ISRO Synthetic Aperture Radar (NISAR) Mission



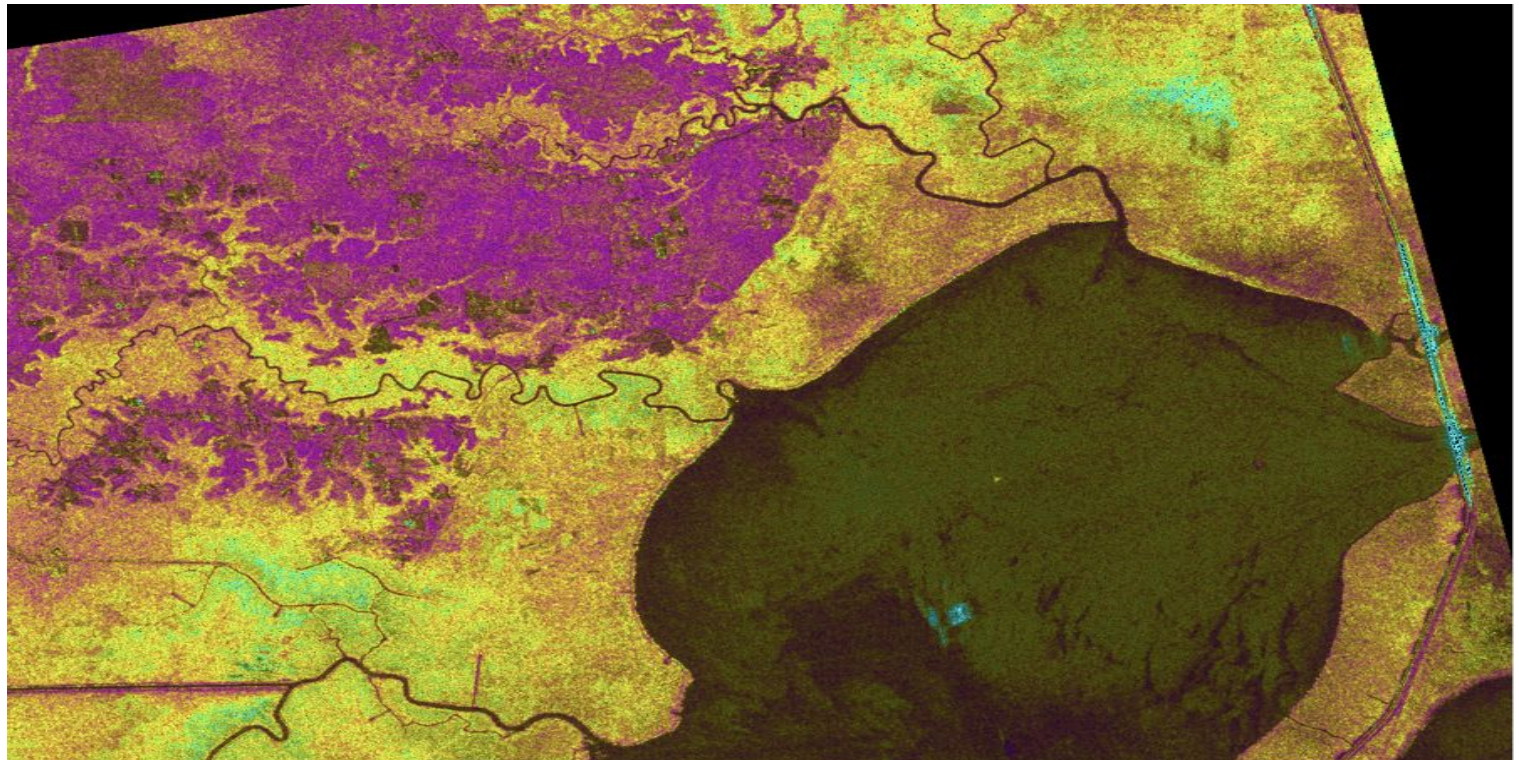
Timely Maps of Flooding

NISAR will be able to map flooding events across the globe twice every 12 days. Observations will be uninterrupted by clouds and can provide timely information for flood responders. Even flooding hidden beneath forest canopies will be visible.



Photos (top-to-bottom): USGS, Coast Guard,White House Archives, FEMA,Doug Wertman (Flickr)

Dual polarization radar image of the Maurepas Lake and surrounding swamp in Louisiana. This image was acquired from space by the Japanese ALOS-2 L-band Radar. In this false color image, yellow areas are flooded Cypress Tupelo swamp, pink are unflooded areas, orange areas are degraded swamp marshes, and dark areas are open water. Image (c) JAXA 2016.



slide courtesy Cathleen Jones

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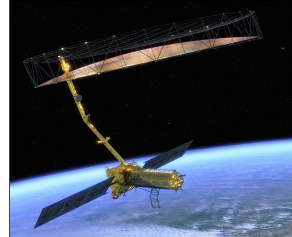
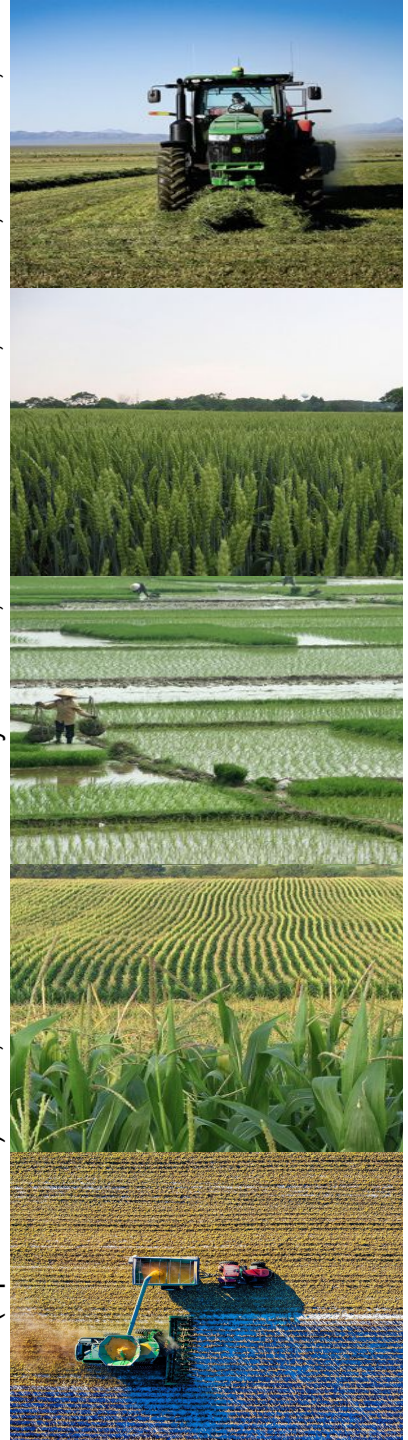
NASA-ISRO Synthetic Aperture Radar (NISAR) Mission





Photos (top-to-bottom): Flickr, CC BY-NC 2.0: Kimberly Reinhart, Jason & Kris Carter, fishhawk, Eric Baker,

Preparing Markets for Bountiful Harvests

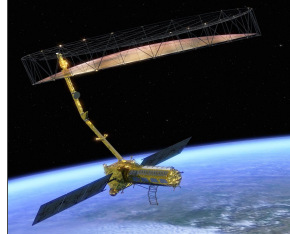
NISAR will provide maps of developing crop area on a global basis every two weeks. Observations will be uninterrupted by weather and provide up-to-date information on the large-scale trends that affect international food security.

Two-frequency (X, L) radar image of the Dnieper River growing region collected in 1994 by NASA's Shuttle Imaging Radar program. In this false color image, developing wheat fields show up as bright magenta and forests as the bright white patches that follow the river's border. It is early in the growing season so most of the fields have little vegetation.

slide courtesy Cathleen Jones

nisar.jpl.nasa.gov

NASA-ISRO Synthetic Aperture Radar (NISAR) Mission

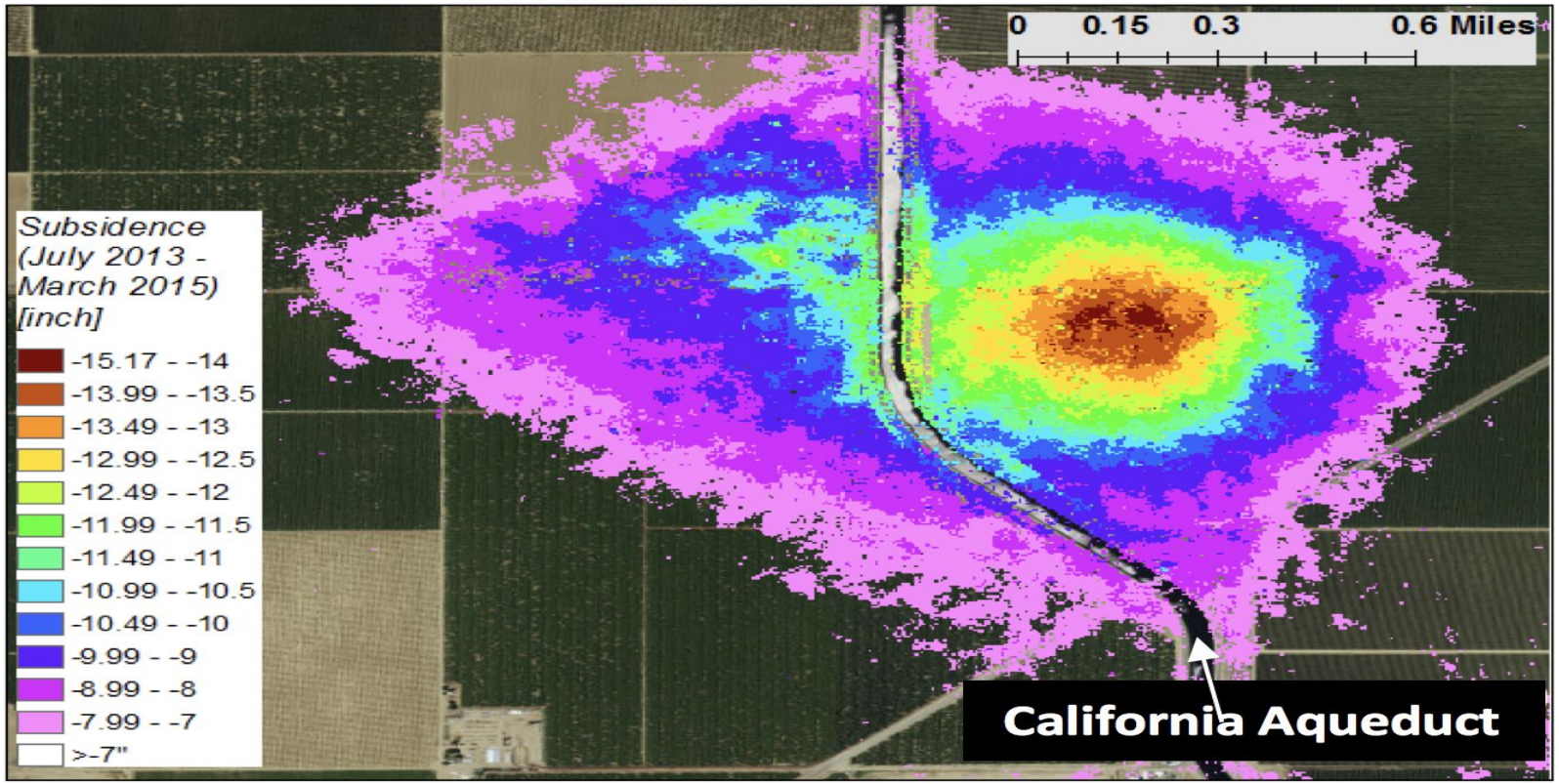


Drought and the Rapidly Changing Landscape

Photos (top-to-bottom): Ca. Dept. of Water Resources, Ca. Dept. of Water Resources, USGS, Va. Water

Droughts are accompanied by a host of troubles. The reduced surface water capture and supply results in more groundwater withdrawal, which in turn leads to ground subsidence that can impact infrastructure and even exacerbate future flooding in the very areas hardest hit by the drought.

SAR-derived map of ground subsidence in the Central Valley, California, associated with groundwater pumping [Farr et al., 2015].



slide courtesy Cathleen Jones

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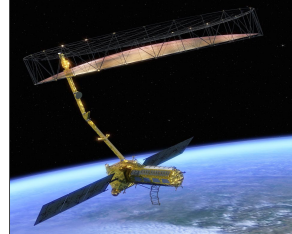
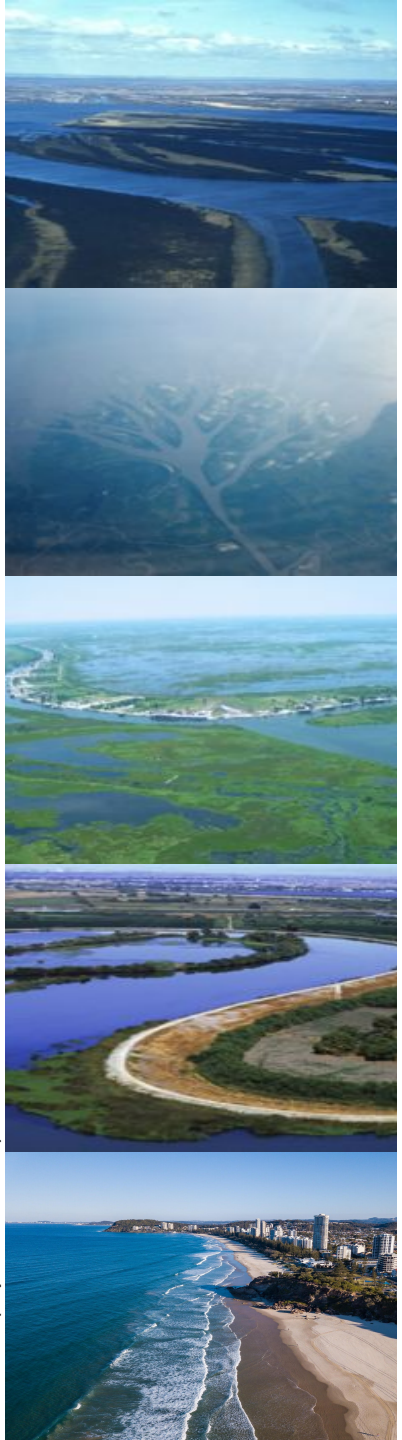
NASA-ISRO Synthetic Aperture Radar (NISAR) Mission

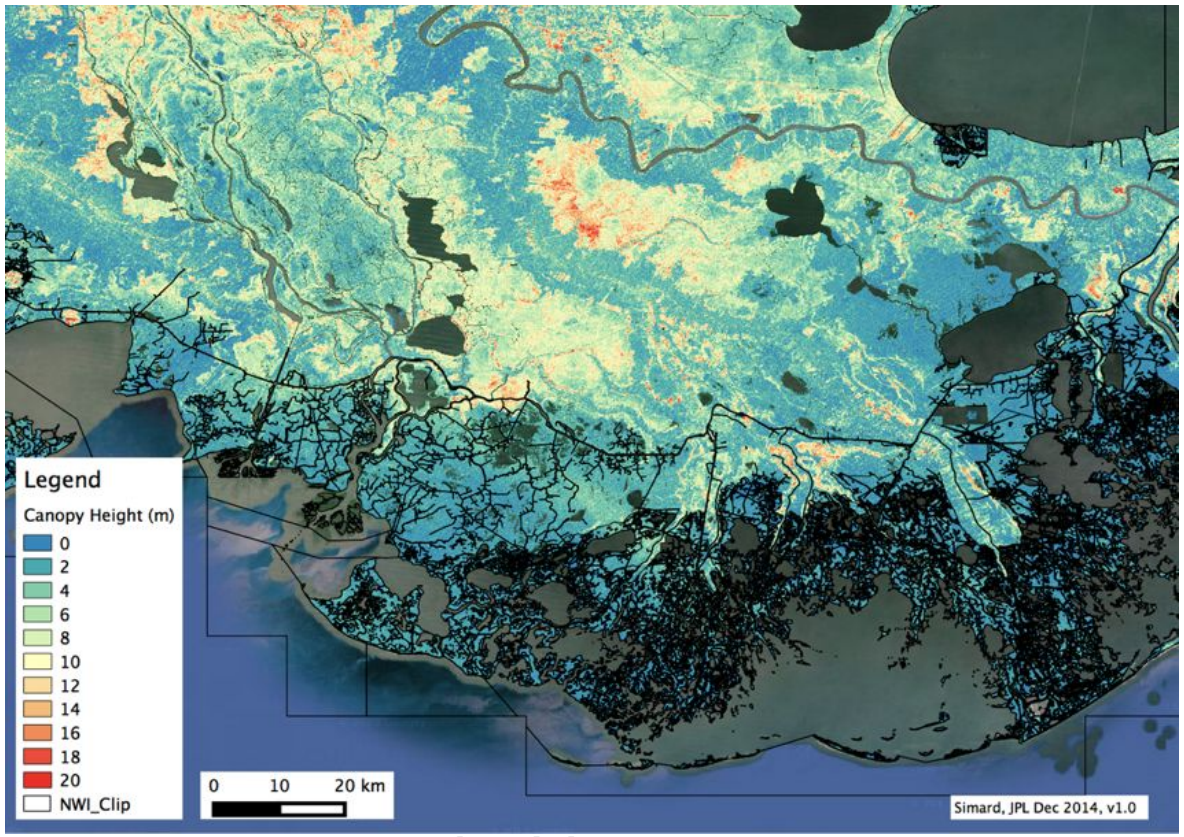


Coastal Regions and Ocean Moods

Coastal regions contain rich environments that provide livelihoods for millions of people worldwide. However, because of their location at the margin between land and water, these areas are at risk from fluctuating conditions that exacerbate land loss, threatening the very ground beneath people's feet. NISAR microwave radar will enable reliable and repeated measurements to be made of the coastal and inland large water bodies, informing land managers world-wide.

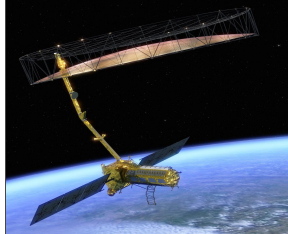


Photos (top-to-bottom): U.S. Fish & Wildlife Service, NASA/JPL-Caltech, California DWR, USGS, Damon Hall



SAR-derived map of the Mississippi River Delta in Louisiana, USA, showing vegetation canopy height.

NASA-ISRO Synthetic Aperture Radar (NISAR) Mission



slide courtesy Cathleen Jones

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NISAR Science Community Workshop

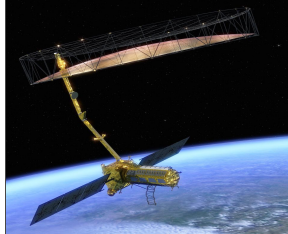
August 30 to September 1, 2022
Pasadena Convention Center, Pasadena, CA

QR Code for website with workshop material

Agenda, presentations ad recordings are posted on NISAR website under “Events”:

- https://nisar.jpl.nasa.gov/events/85/2022-nisar-science-community-workshop/

- PDF of presentations are posted
- Recordings of Plenary Talks are posted
  - *Problem with audio for Wednesday afternoon recordings…*
- Posters were not submitted electronically, will not be posted



NISAR's launch readiness date has been delayed

A new date will be determined at the end of April 2024

Testing and analysis identified a potential for the reflector to experience higher-than-previously-anticipated temperatures in its stowed configuration in flight.

A special coating being added will limit the temperature by reflecting more solar radiation off the reflector hardware. Due to the reflector's size and complexity, it is being shipped from the ISRO site in India where the satellite is being assembled to a specialized facility in California for the application of the coating.

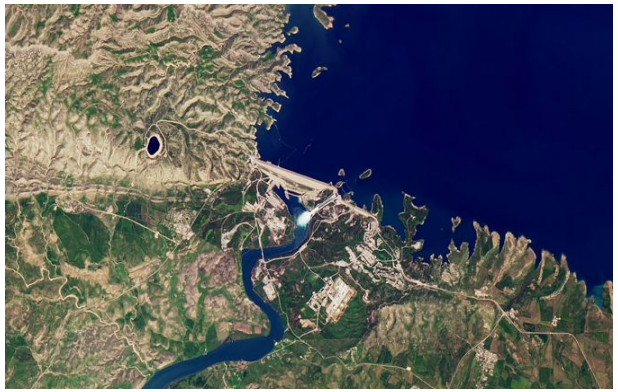
Once the thermal performance of the coating has been fully verified, a launch readiness date will be set.

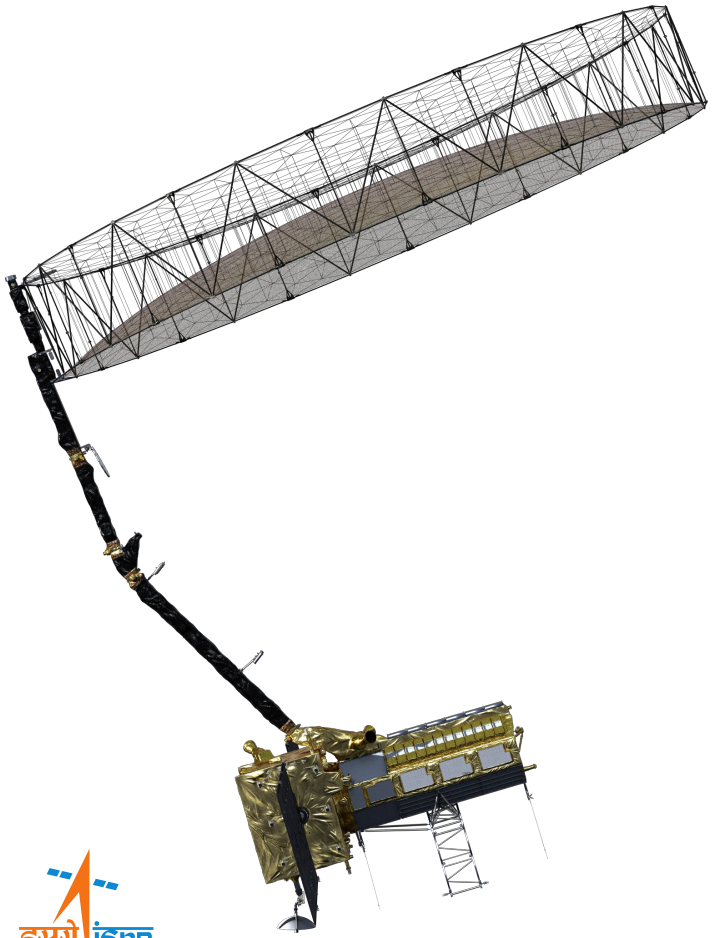
When the reflector returns to India, teams from NASA's Jet Propulsion Laboratory and ISRO will reintegrate it onto the satellite.

https://blogs.nasa.gov/nisar

Courtesy Gerald Bawden





Thank You!

nisar.jpl.nasa.gov

Jet Propulsion Laboratory
California Institute of Technology

NISAR
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