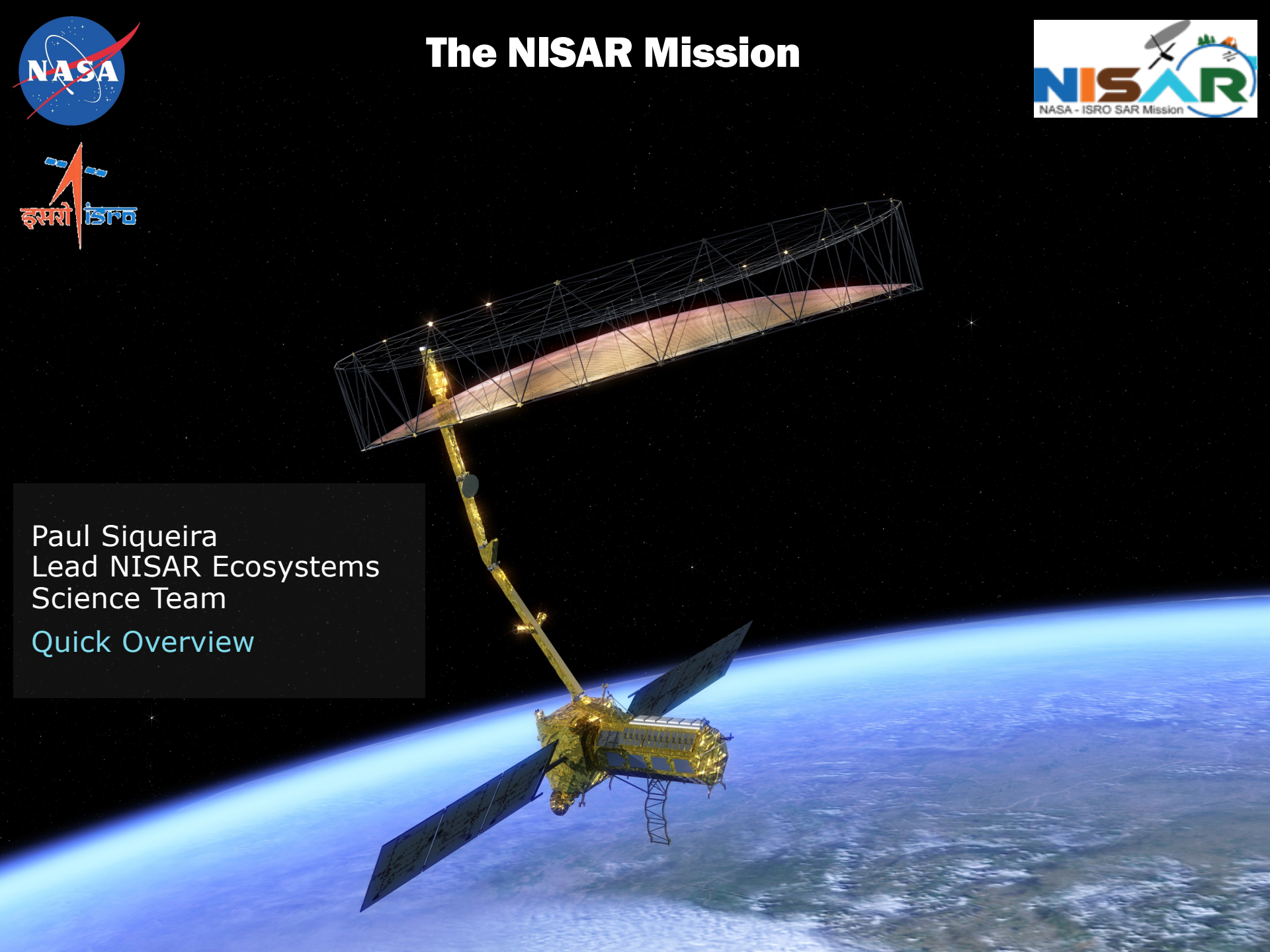
The NISAR Mission



Paul Siqueira
Lead NISAR Ecosystems Science Team

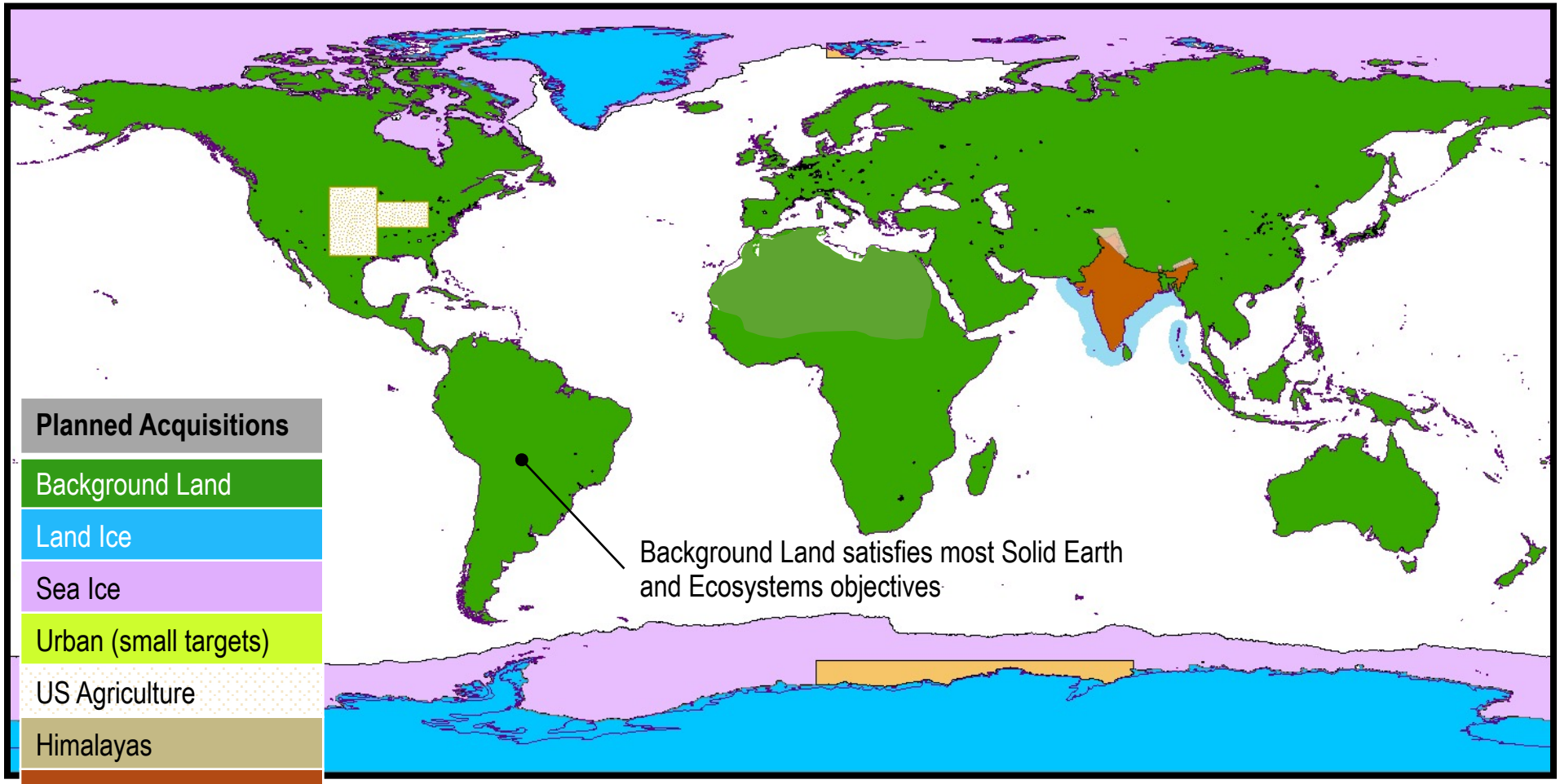
Quick Overview

NISAR Mission at a glance

- Four Level-1 Disciplines
  - *Ecosystems/Hydrology, • Ice Sheets, • Solid Earth Dynamics, • Applications*
- L- & S-band 12-day orbital repeat, left-looking only mission (observations are during ascending and descending passes, so effectively two observations every 12 days)
- 240 km swath using SweepSAR
- Dominant observing mode is L-band dual-pol, 20 m multi-looked resolution. S-band collected outside of India at Cal/Val sites.
- Launch in September 2023 or January 2024
- 4.5 TB/day data downlink
- NISAR is a requirements driven mission.
- Example of a NISAR requirement (biomass):

  NISAR will estimate global above ground biomass up to 100 t/ha at a 1 ha resolution, with an accuracy of 20 t/ha.
- NISAR reliable time-series observations will provide an unprecedented tool for monitoring the terrestrial environment and ecological habitats

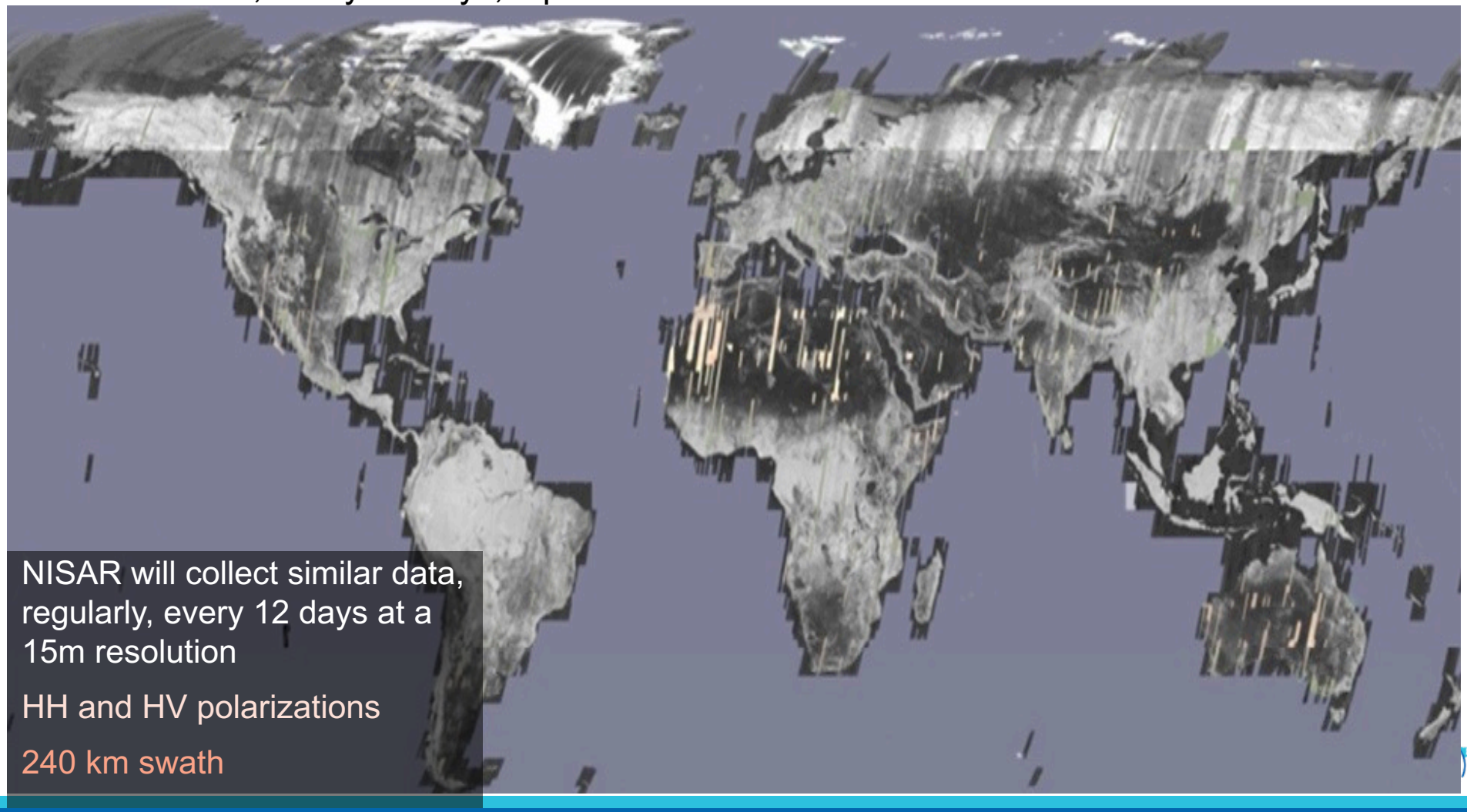
Mode-Specific Science Targets in Observation Plan



US-Quad-pol collection is likely to occur for the states of: Illinois, Michigan, Ohio & parts of Alaska

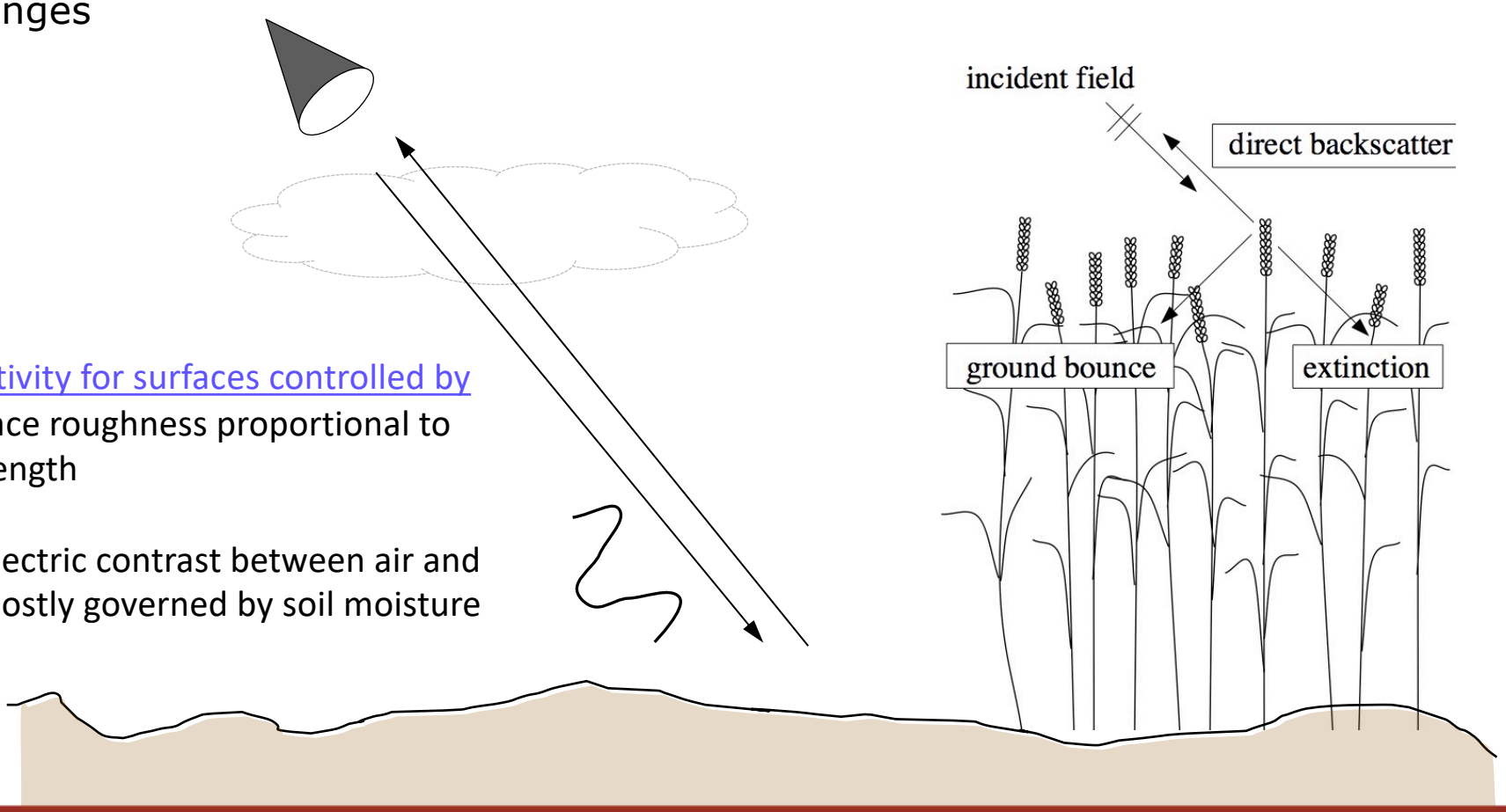
SAR coverage (JERS-1)
What Global L-band looks like

- Active sensor and weather tolerance improves dependability
- For JERS-1, Every 44 days, a partial view of the Earth's surface could be made



A short tutorial for microwaves

- Primarily sensitive to vegetation/surface structure and soil moisture and freeze/thaw state
- As plants and trees grow, the balance between surface and volume scattering changes

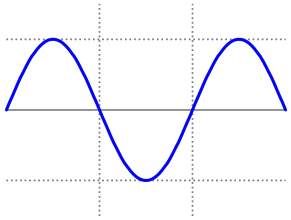


Reflectivity for surfaces controlled by

- surface roughness proportional to wavelength
- dielectric contrast between air and soil, mostly governed by soil moisture

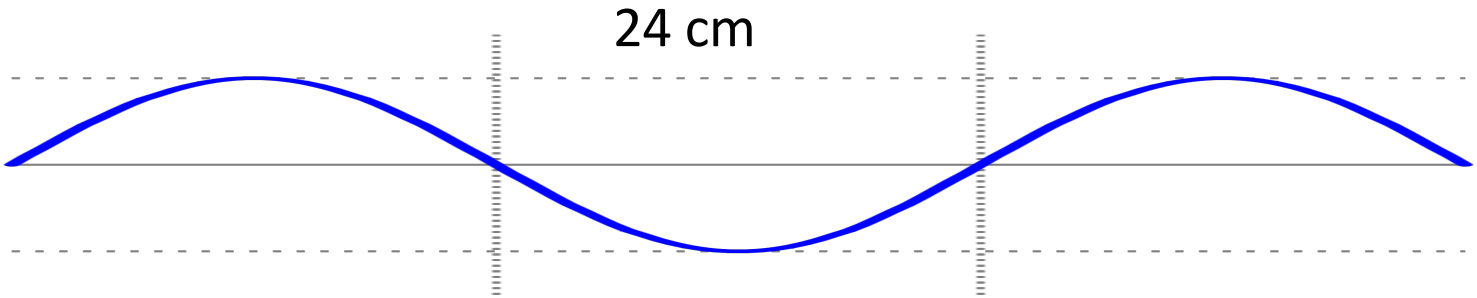
Wavelength

- C-band (5.4 GHz; Radarsat & Sentinel-1)



5.5 cm

- L-band (1.24 GHz; ALOS & NISAR)



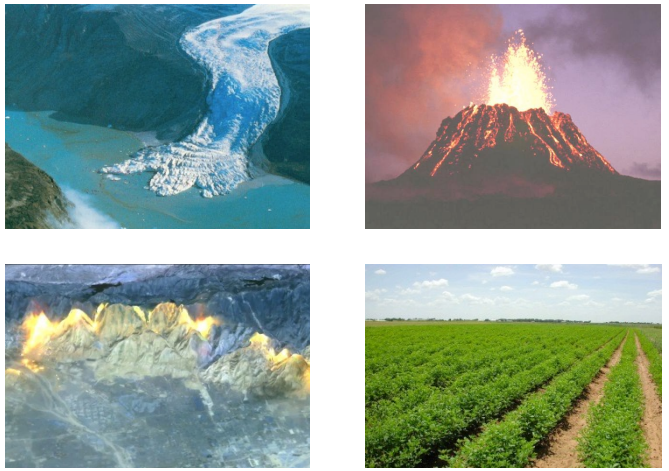
- Green light (Landsat, MODIS & Sentinel-2)

500 nm = 0.0005 cm

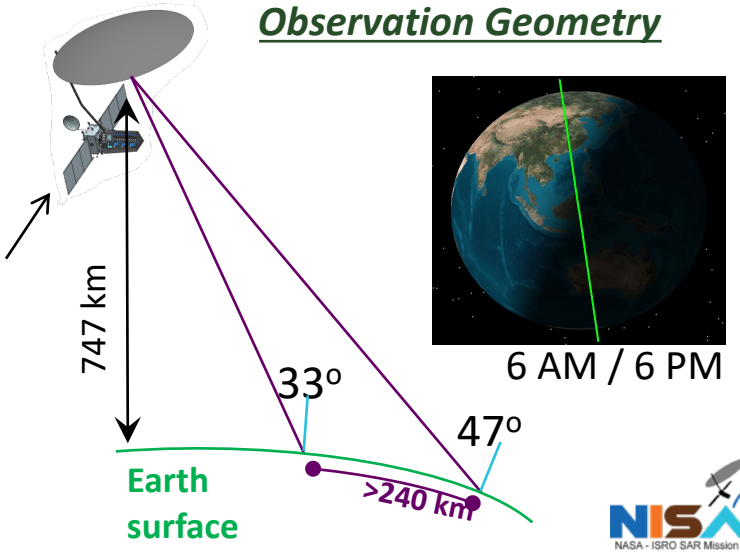
NISAR Concept Science Observation Overview

NISAR Characteristic:	Would Enable:
L-band (24 cm wavelength)	Low temporal decorrelation and foliage penetration
S-band (12 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 years science operations (5 years consumables)	Time-series analysis
Pointing control < 273 arcseconds	Deformation interferometry
Orbit control < 500 meters	Deformation interferometry
> 30% observation duty cycle	Complete land/ice coverage
Left/Right pointing capability	Polar coverage, north and south

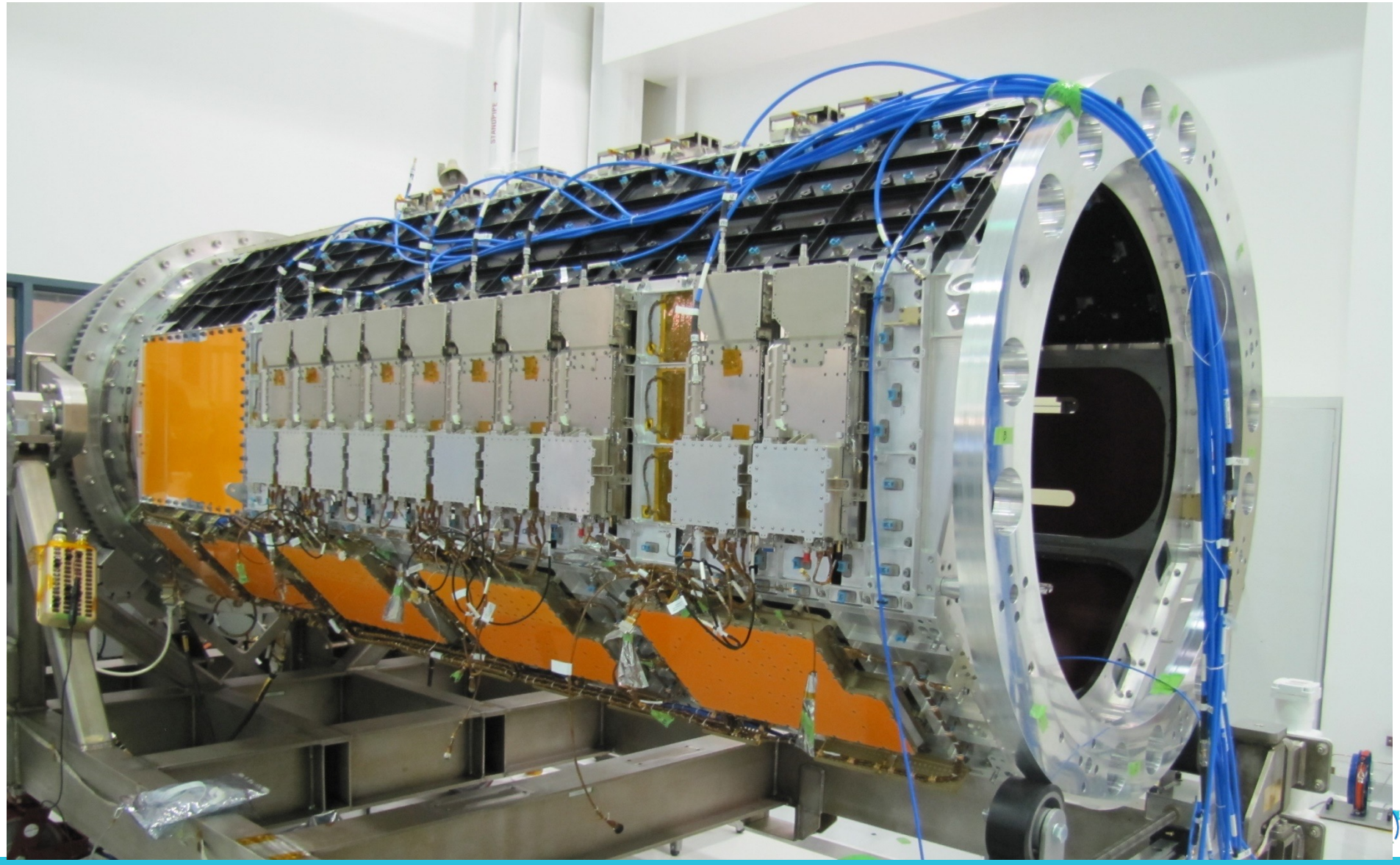
NISAR Would Uniquely Capture the Earth in Motion



Observation Geometry

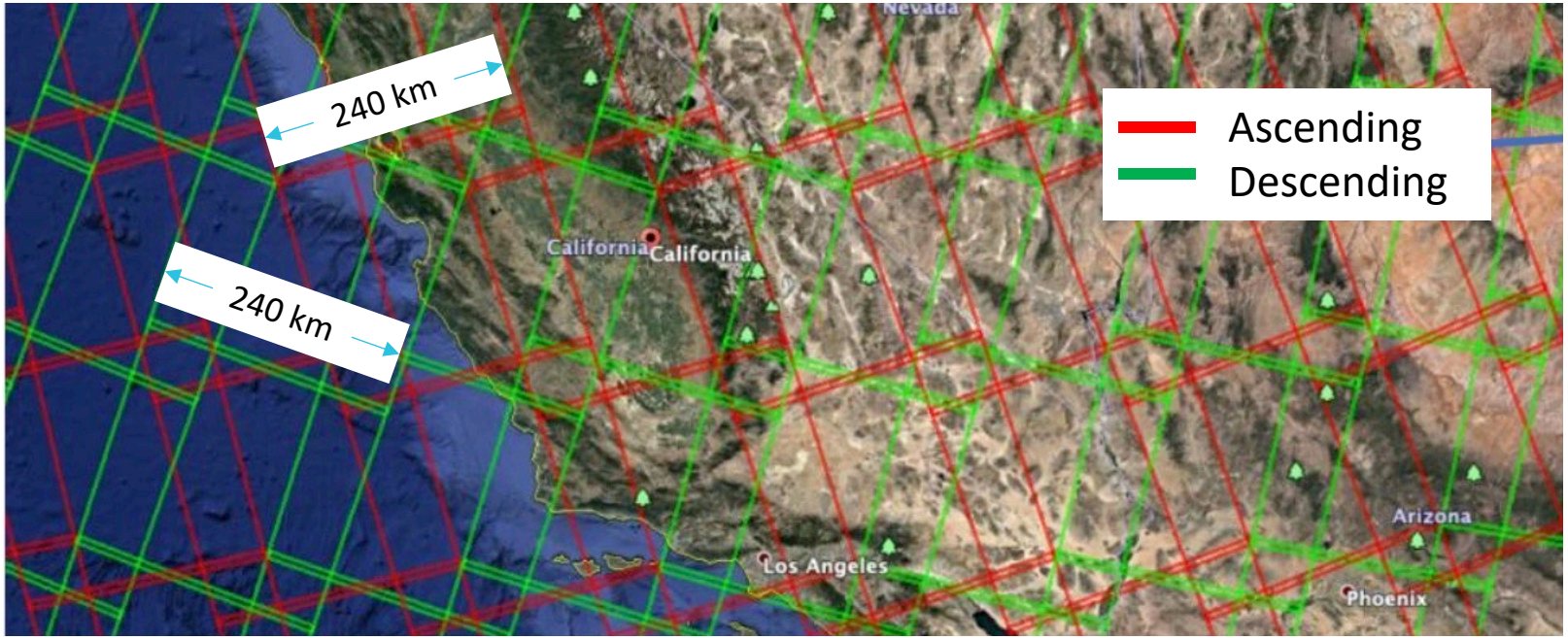


L-SAR Integration is Complete



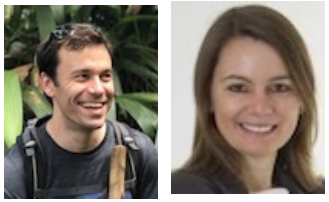
Track/Frame data collection

- Data are planned to be collected in track/frame coordinate system
- 173 unique tracks that comprehensively span the equator
- Within a single track/frame, data collection mode will be uniform, at the lowest bandwidth
- Higher bandwidth segments delivered separately



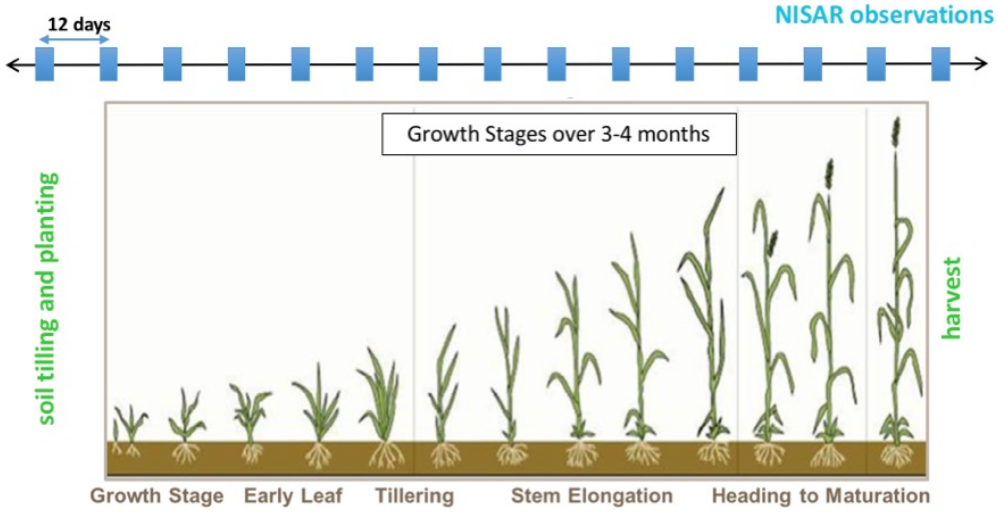
NISAR Development at NASA: Ecosystems

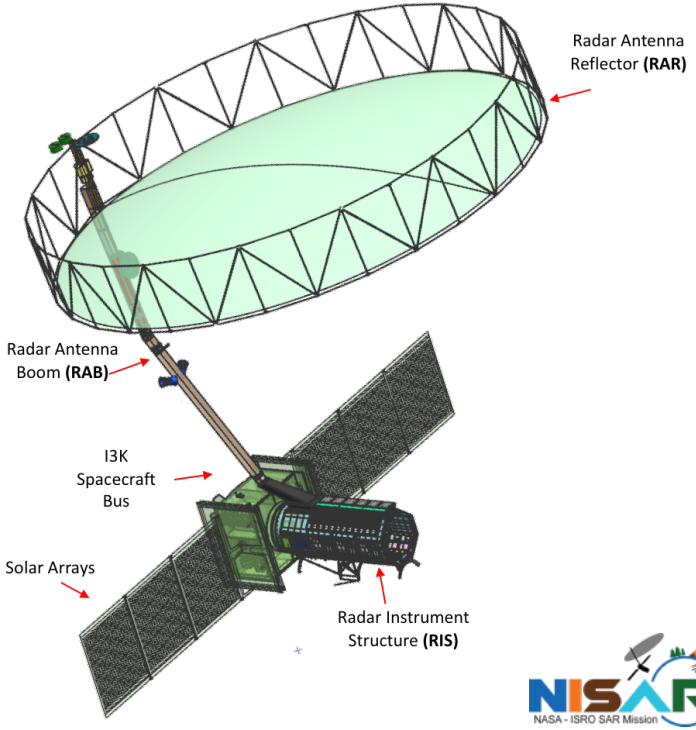
- Biomass
- Disturbance
- Inundation
- Agriculture



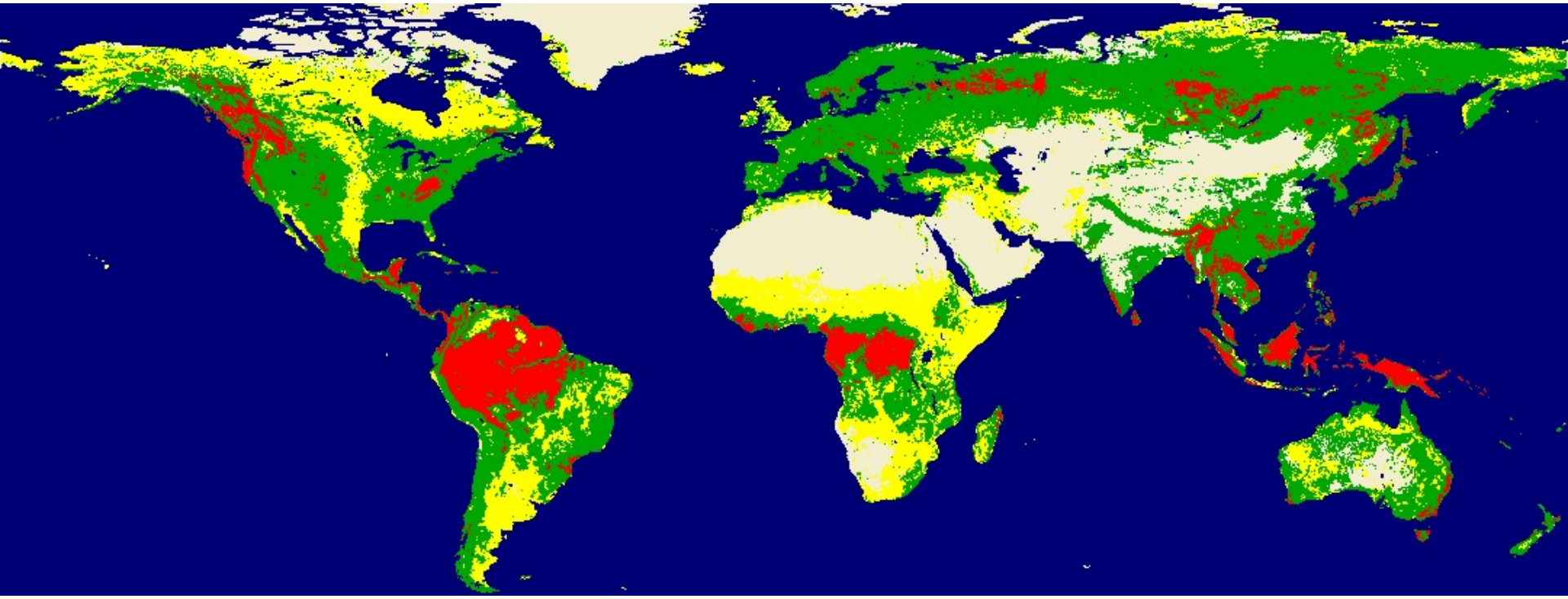
Dense-time series of L-band data (dual-pol)

60 observations/year





NISAR Biomass areas (< 100 tons/ha)



The global distribution of regions dominated by with woody biomass < 100 Mg/ha

Regions with AGB < 100 Mg/ha 50% of area

Regions with AGB > 100 Mg/ha 50% of area

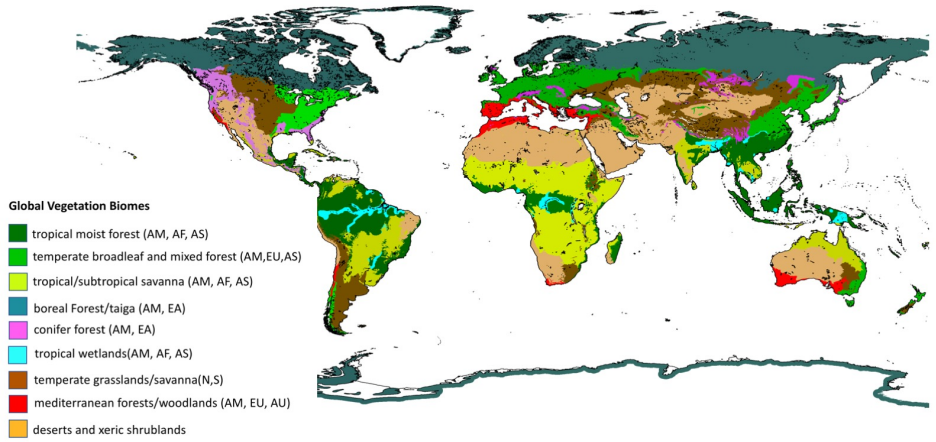
Regions with AGB < 20 Mg/ha 50% of area

Regions with No woody vegetation

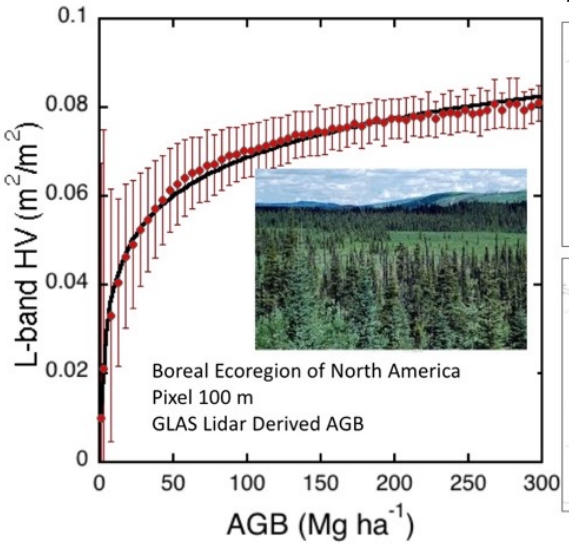
Open Water

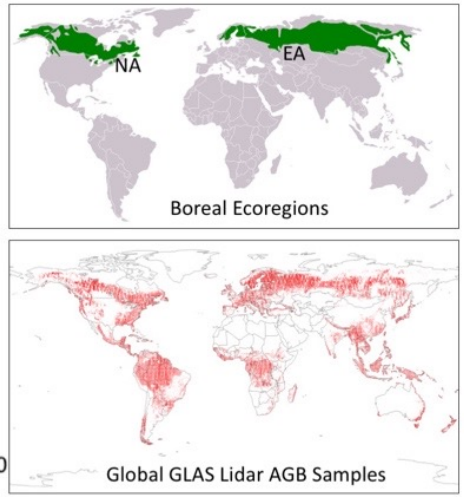
NISAR Biomass

Global Vegetation Biomes

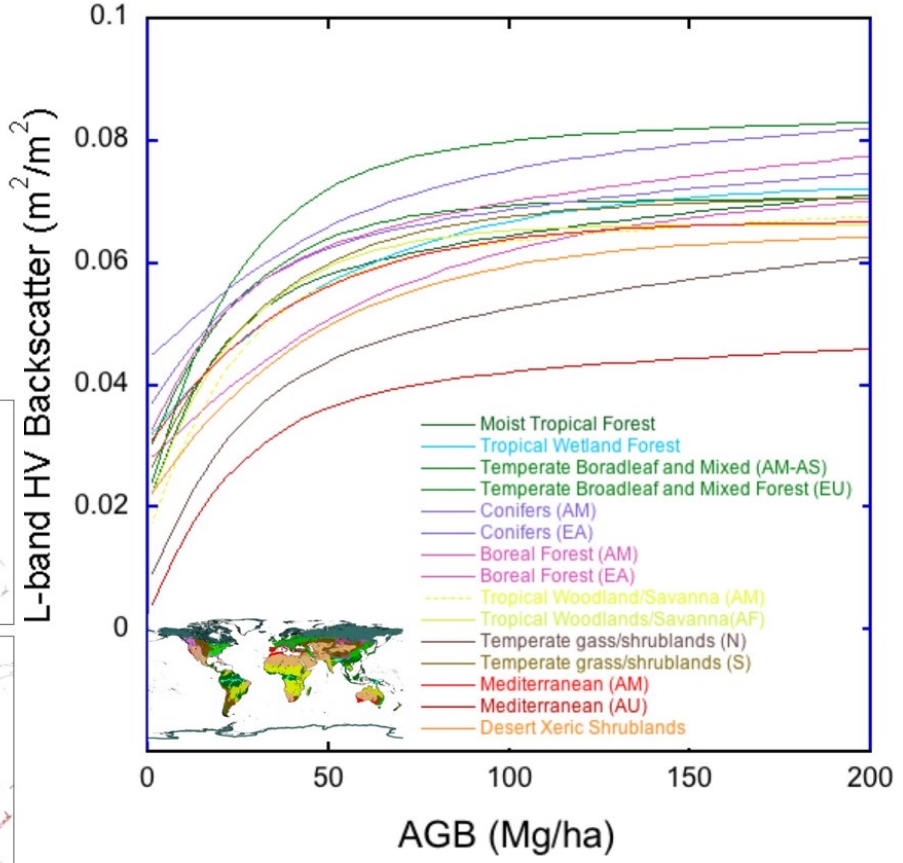


Yu and Saatchi, 2016



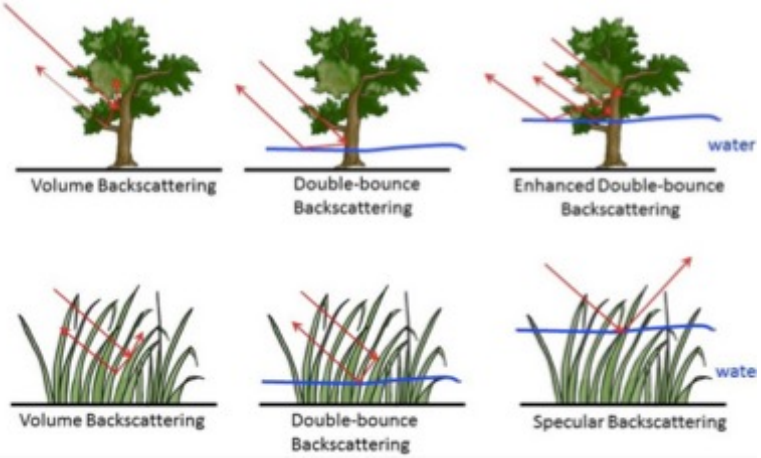


Observing System Simulation Experiment:
A total of 15 ecoregion specific backscatter models are required for NISAR biomass products



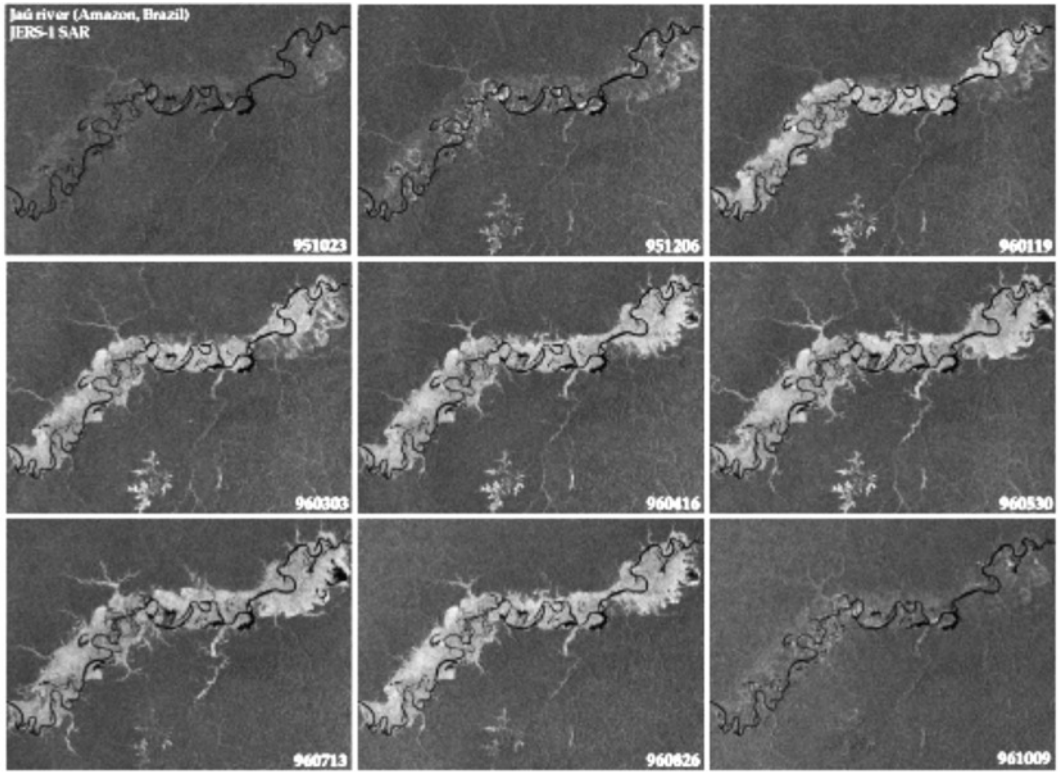
Vegetation Inundation Dynamics

L-band SAR observations are established as the most reliable tool for mapping vegetation inundation



- Existing L-band SAR satellites have limited coverage and observations to accurately capture the spatial extent and temporal variations of inundation over wetlands.
- NISAR plans to acquire minimum of dual-pol data globally over all wetlands twice per 12 day orbit cycle will contribute significantly to understanding wetland hydrology and the impacts of climate variations

JERS-1 L-band SAR (HH only) data showing inundation dynamics for 1 year (Jau River, Brazil)



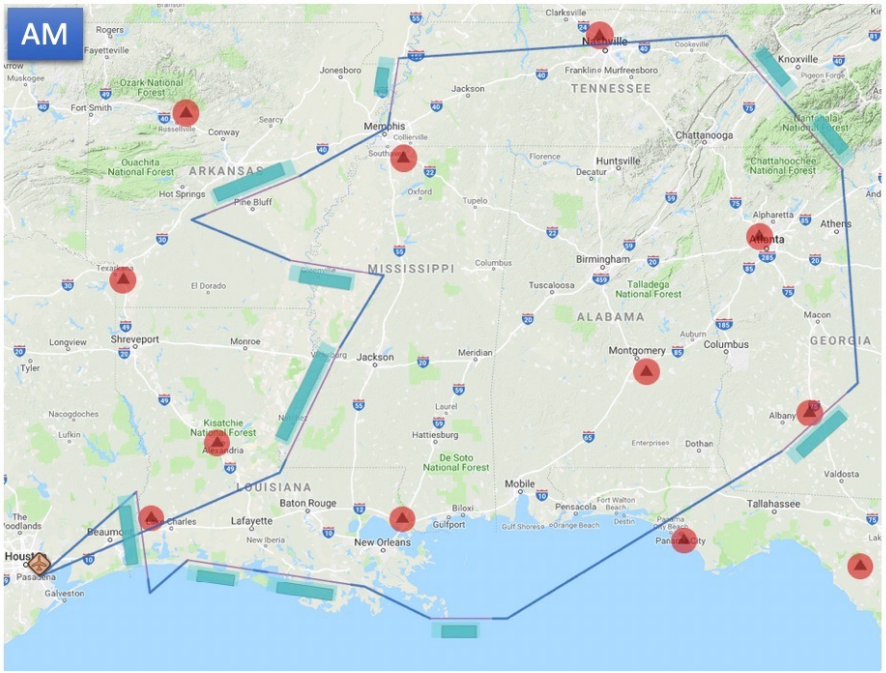
Rosenqvist et al, 1998.

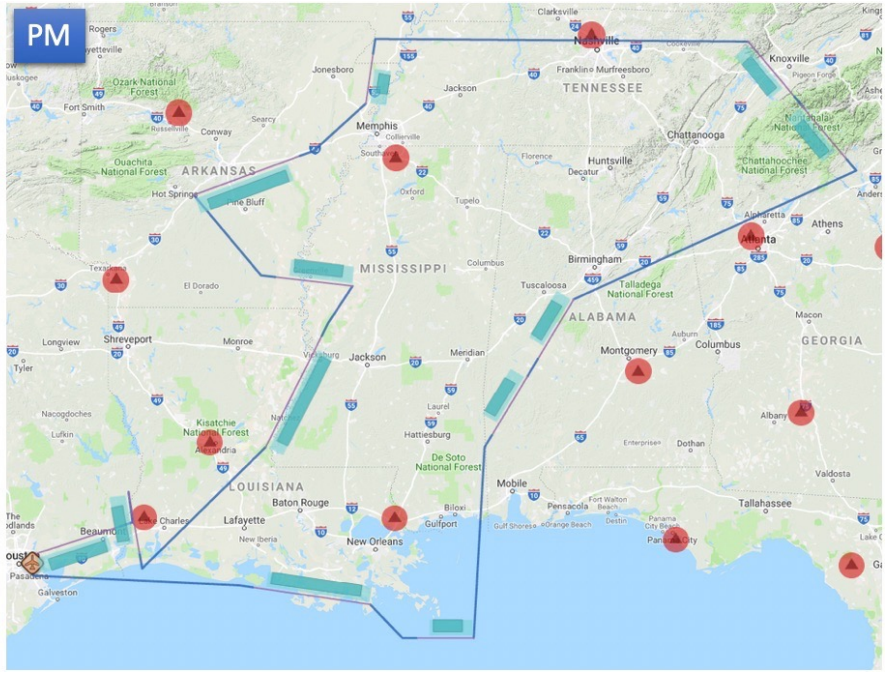
Nominal Ecosystem Cal/Val sites
Biomass/Disturbance/Wetlands/Agriculture

https://nisar.jpl.nasa.gov/files/nisar/NISAR_Science_Users_Handbook.pdf

NISAR Ecosystems/Hydrology UAVSAR AM/PM Campaign

- Flight coverage

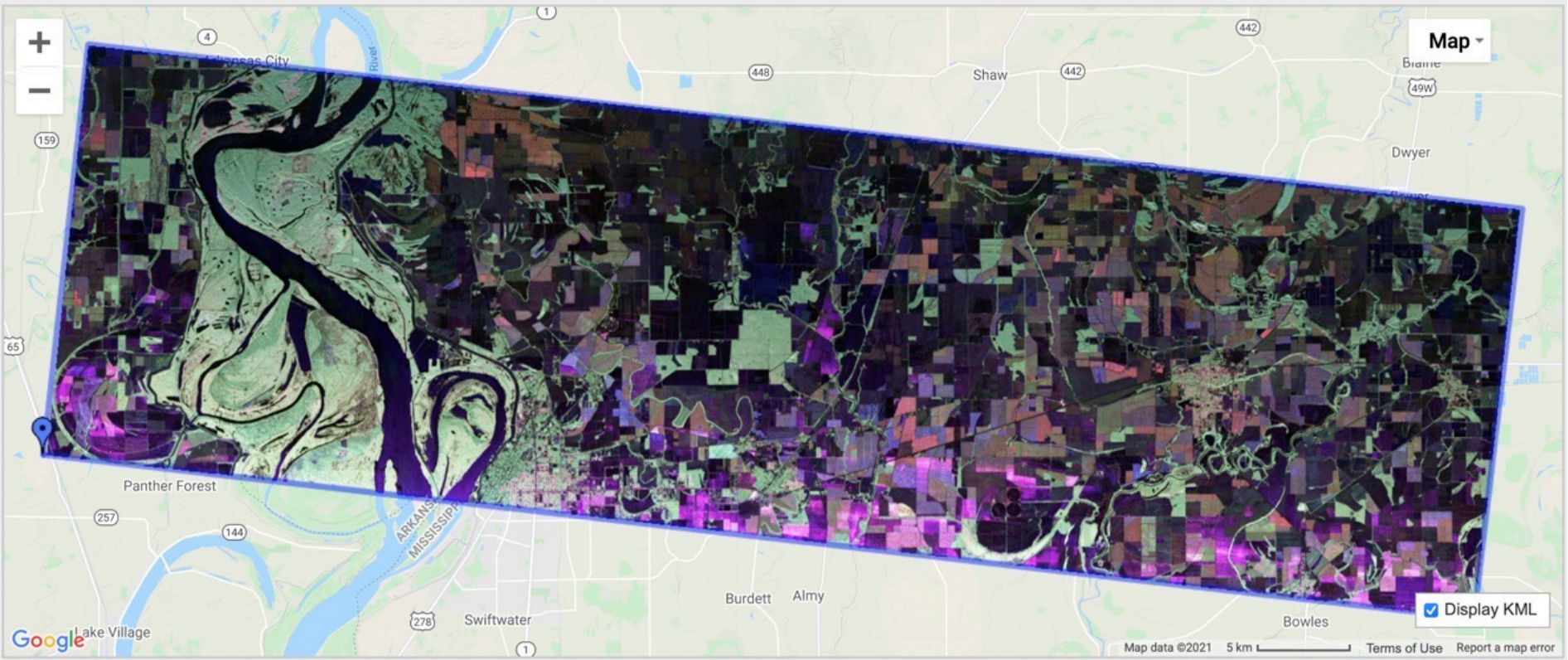




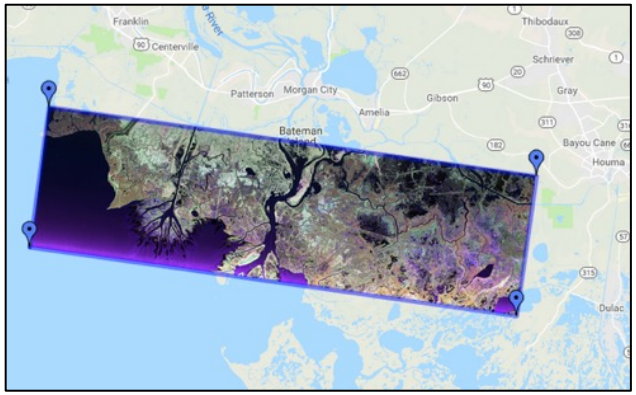
- Mimic the NISAR diurnal observing pattern in a hydrologically dynamic environment
- 14 sites that cover Biomass, Disturbance, Wetlands, Agriculture, Soil Moisture diversity, Oil spill, Subsidence and other disciplines
- Data collected between June and October 2019 (12 nominal repeats)

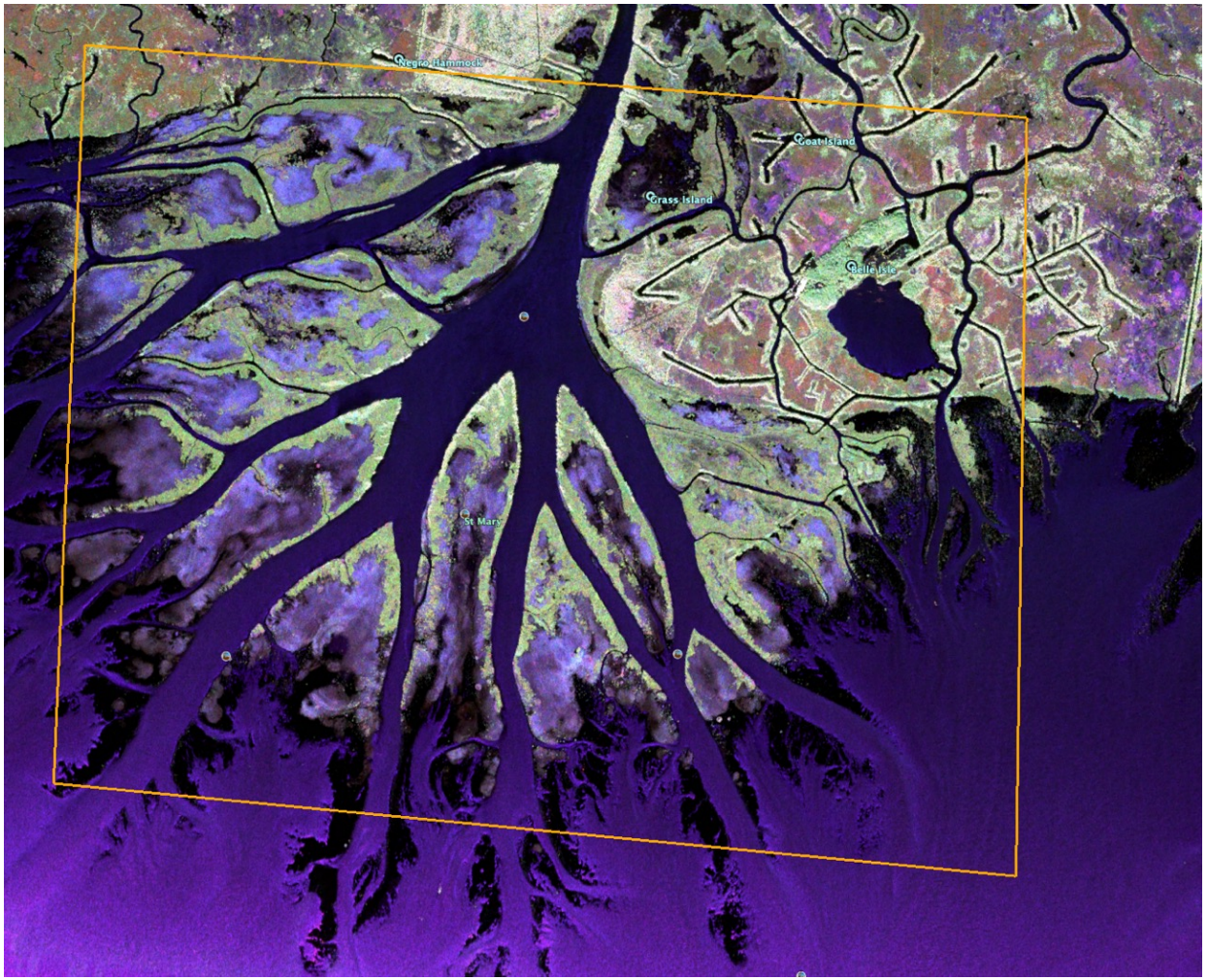
Time series UAVSAR data
Stoneville

HH, HV, VV



NISAR Ecosystems/Hydrology UAVSAR AM/PM Campaign





Learn More about NISAR

https://nisar.jpl.nasa.gov

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Applications

Ecosystem

White Papers

Fire Management (PDF, 1.78 MB)
Food Security (PDF, 1.01 MB)
Forest Resources (PDF, 2.02 MB)
Timber and Forest Disturbance (PDF, 2.7 MB)
Flood Forecasting (PDF, 3.52 MB)

Workshop reports

Vegetation Biomass Workshop Report (June 2016) (I

Maritime Hazards and Coastal Waters

White Papers

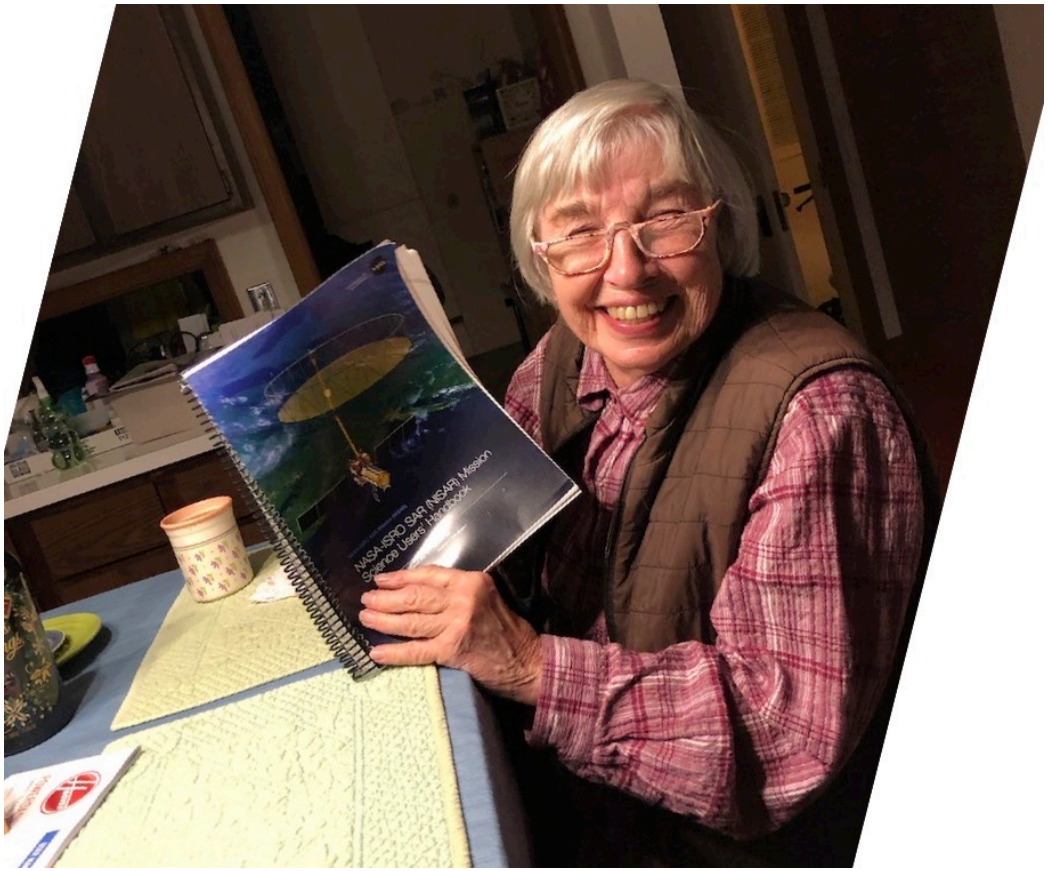
Coastal Land Loss (PDF, 2.56 MB)
Oil Spills (PDF, 3.48 MB)
Ice Sheets, Glaciers, and Oceans (PDF, 1.19 MB)
Marine Hazards (PDF, 1.44 MB)
Sea Ice (PDF, 2.21 MB)

Workshop reports

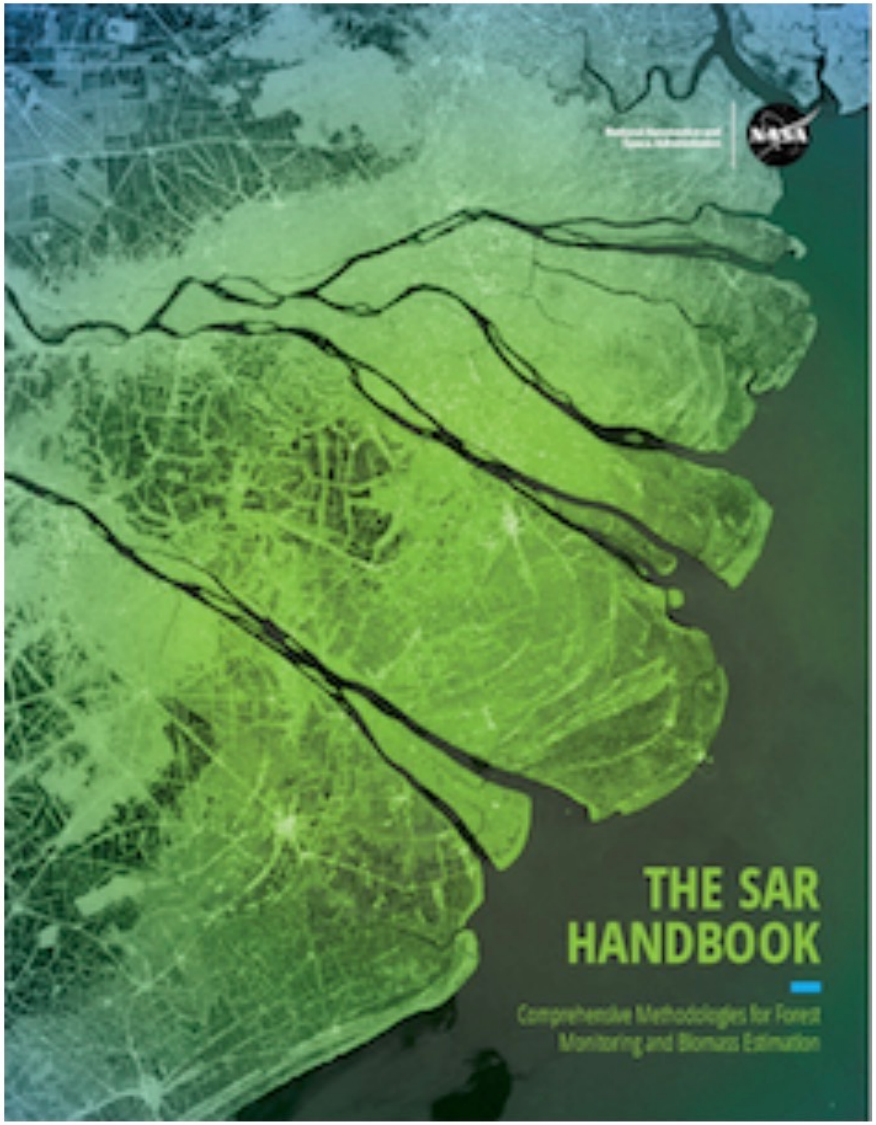
Sea Ice and Ocean Applications Workshop Report (June 2017)

NISAR
Learn More

- NISAR has a 264 page science handbook!
  - Available now as a pdf (nisar.jpl.nasa.gov/getengaged/resources/)
  - Available in hard copy at a NASA center near you!



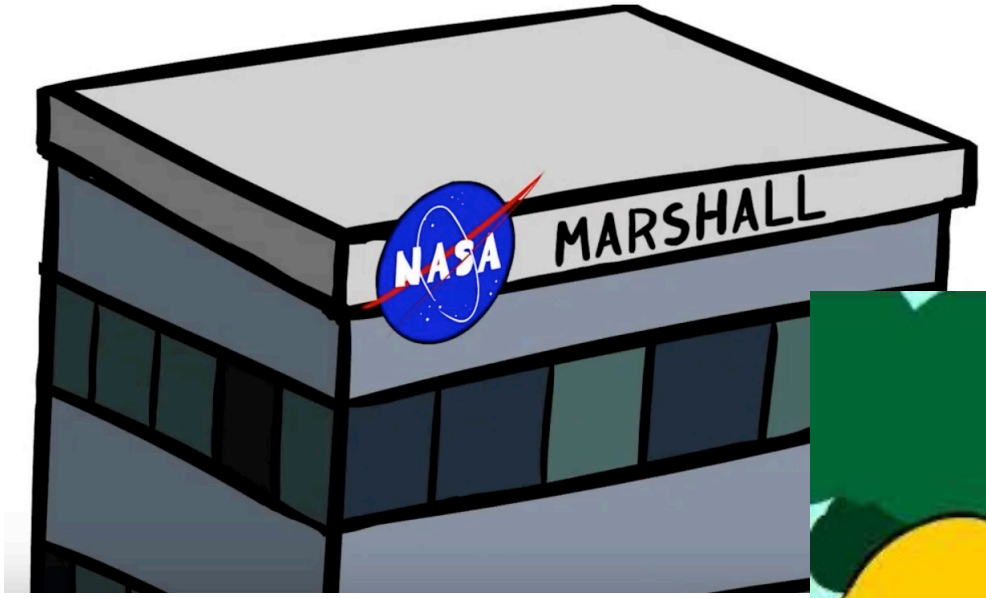
The SAR Handbook
Forest Monitoring & Biomass Estimation

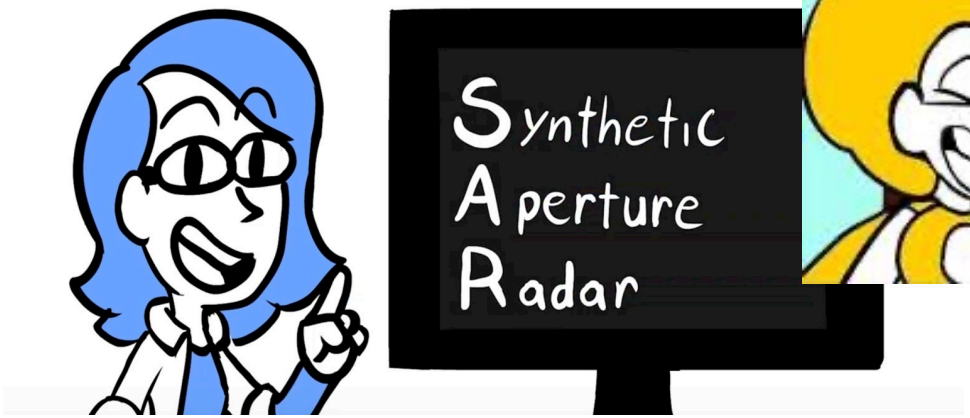


- 7 Technical chapters with examples
  - Basic principles and data access
  - Forest Disturbance Monitoring
  - Forest Stand Height Estimation
  - Biomass Mapping
  - Remote Sensing of Mangroves
  - Sampling Designs for SAR-driven surveys
- Peer reviewed
- Deployed at SERVIR centers distributed worldwide
- Distributed by NASA/Marshall

NISAR Outreach

- You know you have arrived when you have a youtube video





NISAR Ecosystems/Hydrology Status & Upcoming Events

- Status
  - ATBD and Cal/Val plans completed but now being re-reviewed
  - ATBD's are all encoded into Jupyter notebooks
  - Instrument is being assembled at JPL
- UAVSAR AM/PM Campaign
- Other NASA Activities
  - Surface Deformation and Change (SDC)
  - Surface Topography and Vegetation Study
  - NISAR Community Workshop (April 19-21, 2022) Pasadena Convention Center
- Get Ready for NISAR!
  - Learn about how to use SAR data for characterizing the terrestrial environment
  - Work with Sentinel-1 time series (available through ASF)
  - Learn how to work with promoting algorithms to the computing cloud
  - Develop algorithms that utilize time-series as a signature all by itself

Questions?