



The NISAR Mission



Paul Siqueira
Lead NISAR Ecosystems
Science Team
Quick Overview





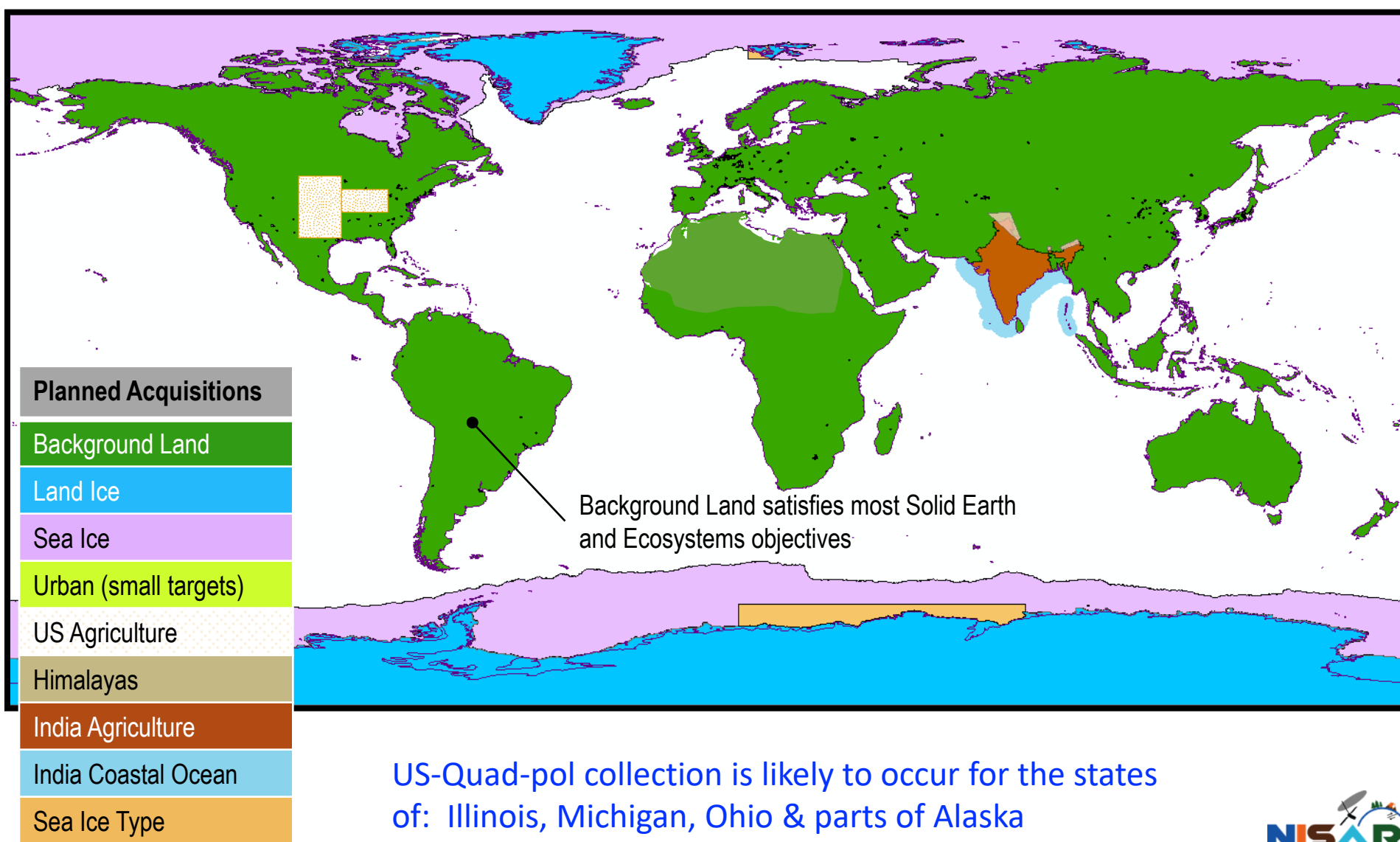
NISAR Mission at a glance

- 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, 10 m resolution (40 MHz US; 20 MHz elsewhere). S-band collected outside of India at Cal/Val sites.
- Launch in 2022 (May)
- 4.5 TB/day data downlink
- NISAR is a requirements driven mission.
- NISAR is not currently delivering any L3 science products (only L2 with L3 algorithms & requirements verified over cal/val sites)
- 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 repeat-observations used to reduce soil moisture and speckle effects in the data.



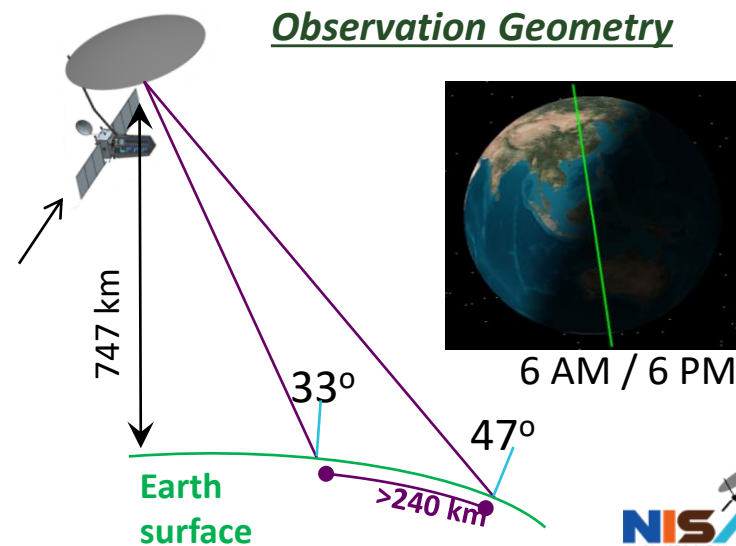
Mode-Specific Science Targets in Observation Plan



NISAR Concept Science Observation Overview

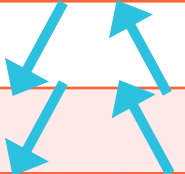
NISAR Characteristic:	Would Enable:
L-band (24 cm wavelength)	Low temporal decorrelation and foliage penetration
S-band (12 cm wavelength)	Sensitivity to light vegetation
SweepSAR technique with Imaging Swath > 240 km	Global data collection
Polarimetry (Single/Dual/Quad)	Surface characterization and 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



Science Observing/Operations Modes (Pre-2016)

- Observation strategy employs a small subset of possible modes

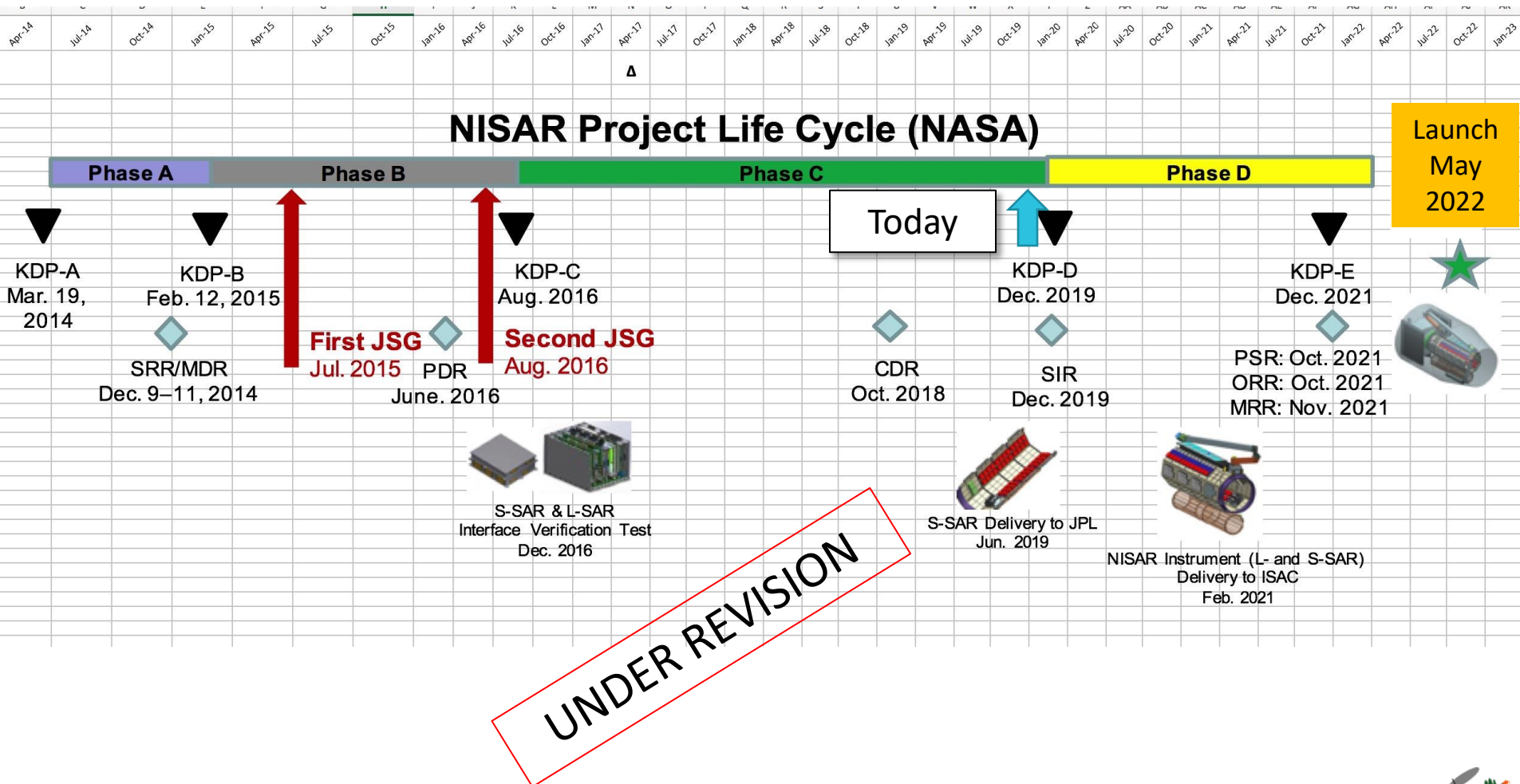
Observation Strategy	L-band		S-band		Culling Approach	
Science Target	Mode ⁺	Resolution	Mode	Resol.	Sampling	Desc Asc
Background Land	DP HH/HV 	12 m x 8 m 			cull by lat	
Land Ice	SP HH 	3 m x 8 m 			cull by lat	
Sea Ice Dynamics	SP VV 	48 m x 8 m 			s = 1 p	
Urban Areas		6 m x 8 m 			s = 1 p	
US Agriculture	QP HH/HV VV/VH 				s = 1 p	
Himalayas			CP RH/RV 		s = 1 p	
India Agriculture					s = 1 p	
India Coastal Ocean			DP HH/HV or VV/VH 		s = 1 p	
Sea Ice Types	DP VV/VH 				s = 3 p	

- New Team!



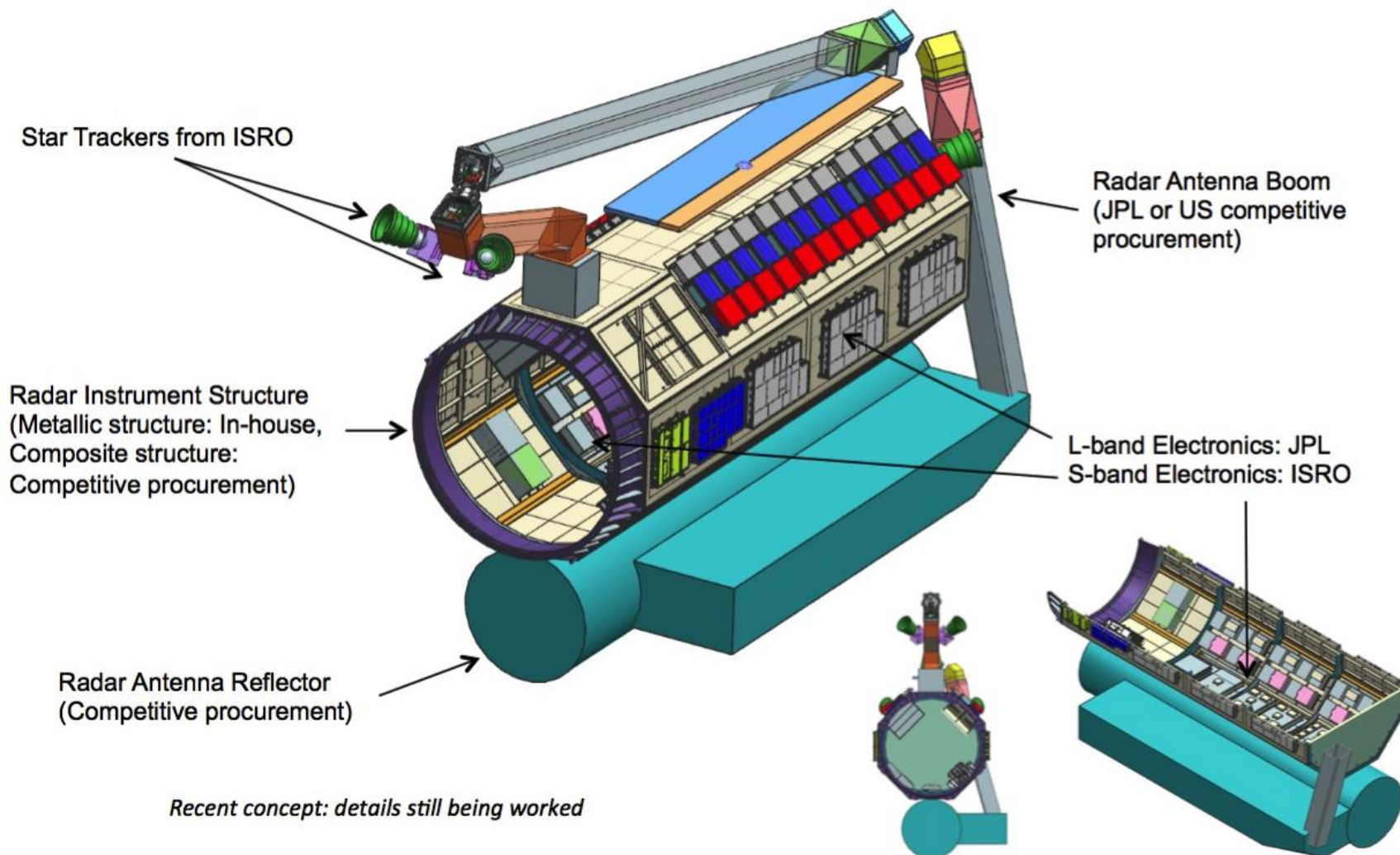
Paul Siqueira, Bruce Chapman, Josef KelIndorfer, Sassan Saatchi, Ralph Dubayah, Nathan Torbick, Narendra Das, Seungbum(Sab) Kim, Rajat Bindlish, Rick Forster, Rowena Lohman, Kyle McDonald

- Currently Ecosystems & Hydrology/Soil Moisture are combined because of the many common themes and interests between the disciplines.
- NISAR Science Team meetings three times yearly





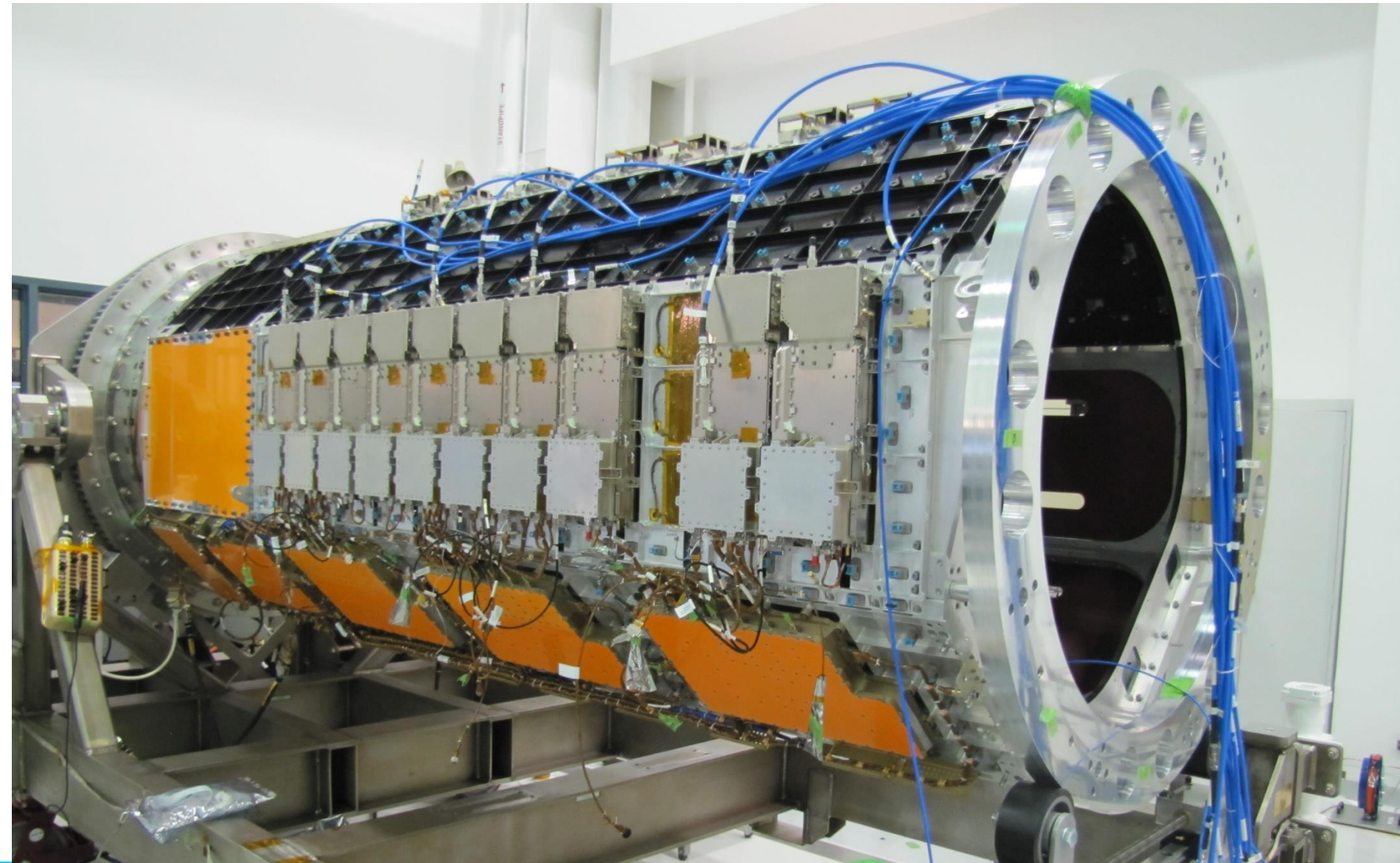
NISAR Stowed Configuration



NISAR Instrument Housing (2015)



L-SAR Integration is Nearly Complete

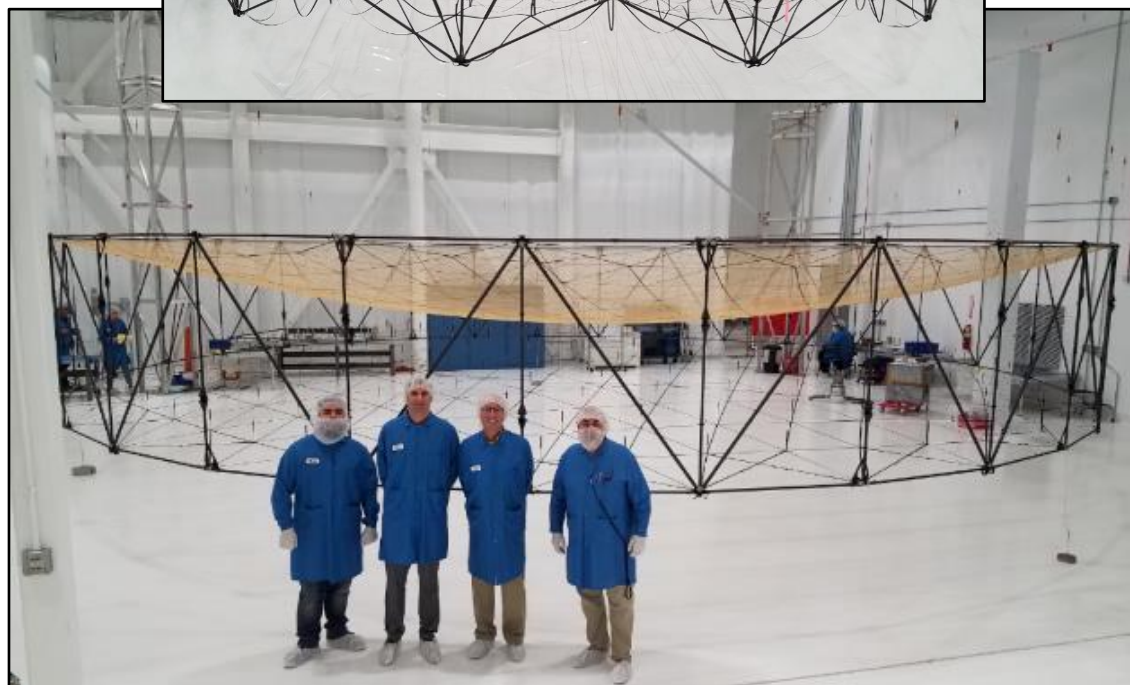




Boom Segments are Complete and Being Integrated



Reflector is in Final Assembly & Test

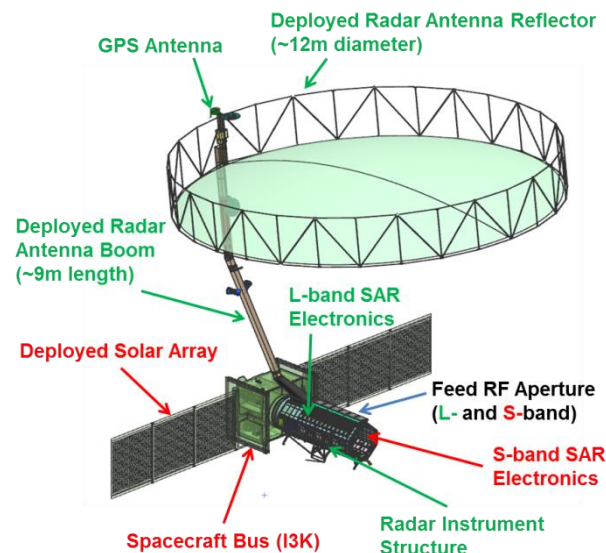


NGAS Astro Aerospace Proprietary

Created under NASA/JPL NISAR Subcontract No. 1537496

NASA-ISRO Observatory Work Share

On-Orbit Configuration



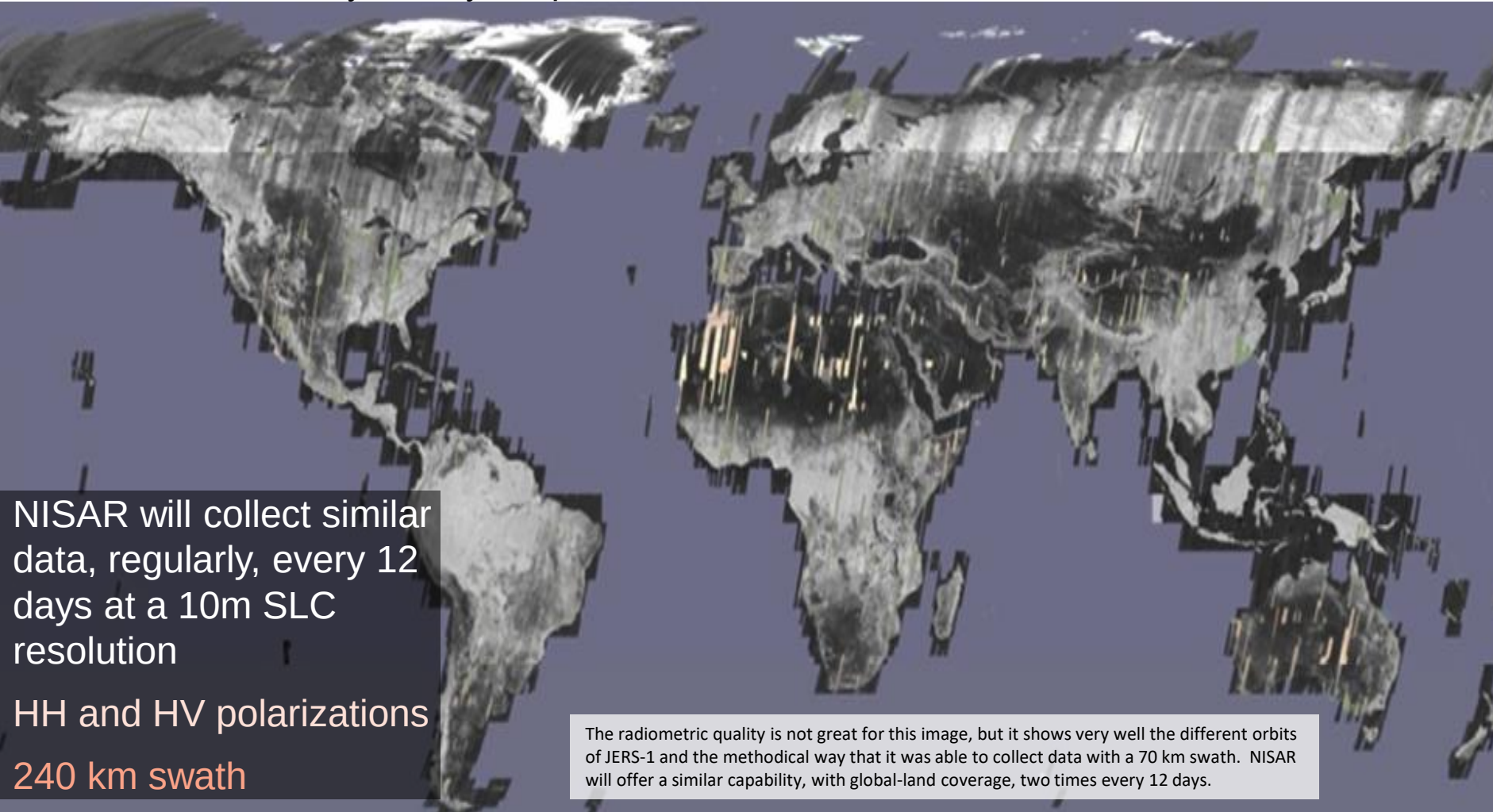
- Spacecraft Bus System (ISRO URSC)
 - I3K heritage bus with modifications
- Radar Payload System
 - L-band SAR aka DSI (NASA)
 - S-band SAR (ISRO SAC)
- Engineering Payload System (NASA)
 - Payload Communication Subsystem (PCS)
 - Ka-band high rate transmitter
 - GPS Payload (GPSP)
 - Solid State Recorder (SSR)
 - Payload Data Subsystem (PDS)
 - Power Distribution Unit (PDU)
 - Pyro Firing Assembly (PFA)
- Launch Vehicle (ISRO VSSC)
 - Geosynchronous Satellite Launch Vehicle (GSLV) Mark-II (4-meter fairing)

DSI = Dual-band SAR Instrument

URSC: U. R. Rao Satellite Centre
 SAC: Space Applications Centre
 VSSC: Vikram Sarabhai Space Centre

SAR coverage (JERS-1)

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



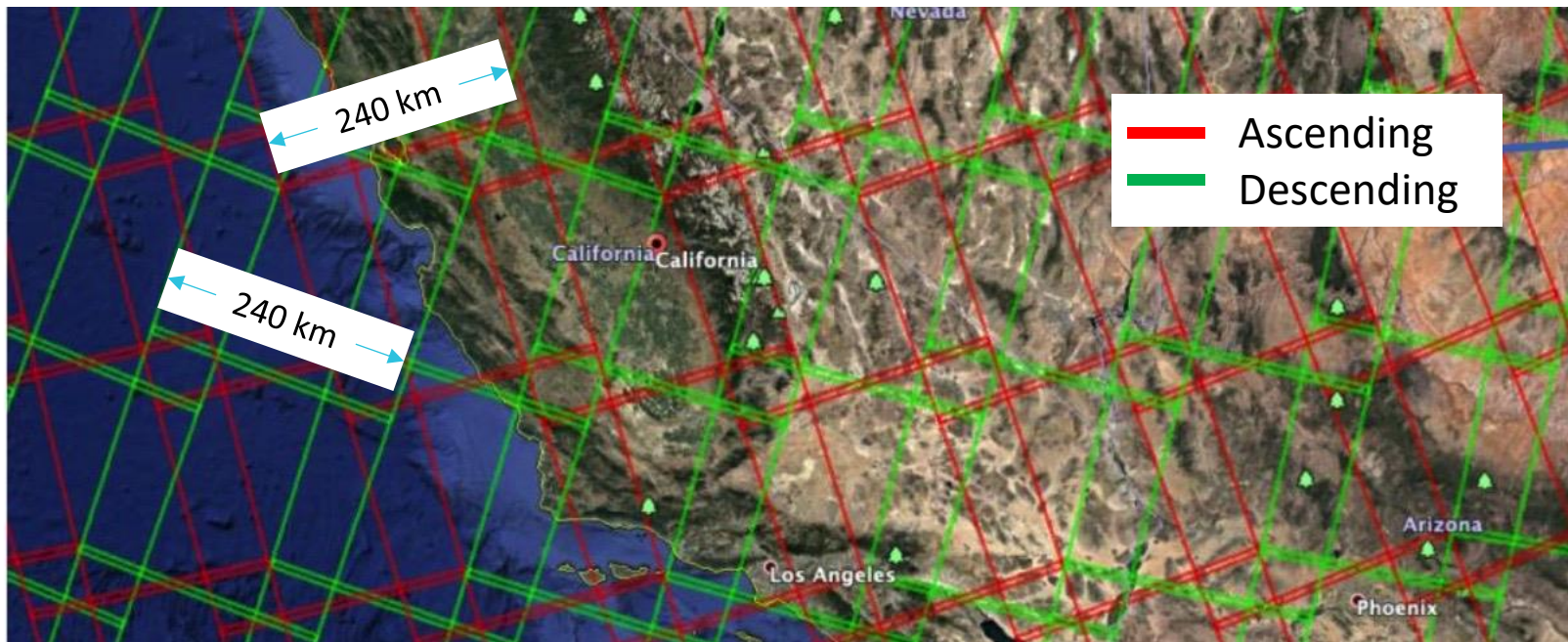
NISAR will collect similar data, regularly, every 12 days at a 10m SLC resolution

HH and HV polarizations

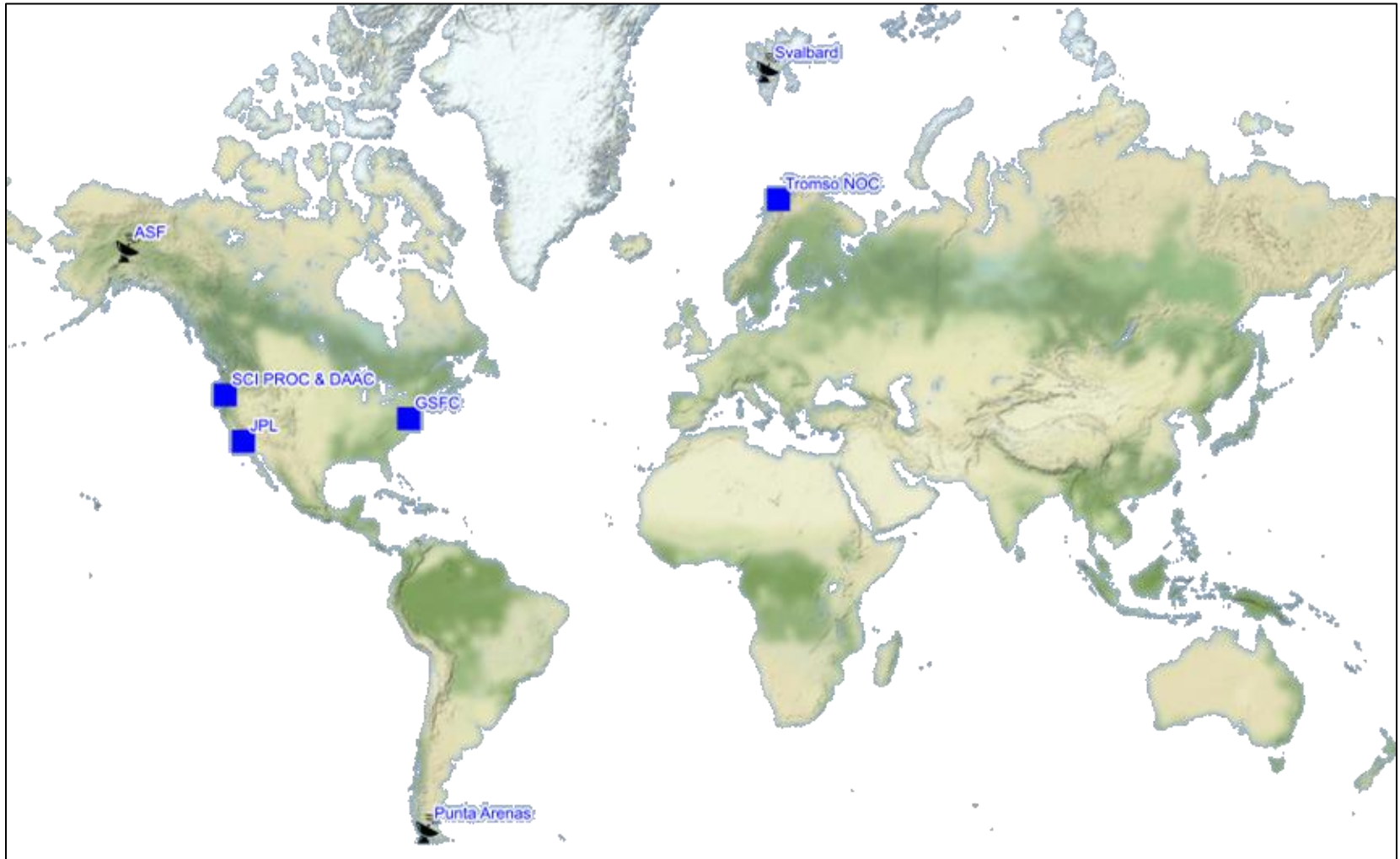
240 km swath

The radiometric quality is not great for this image, but it shows very well the different orbits of JERS-1 and the methodical way that it was able to collect data with a 70 km swath. NISAR will offer a similar capability, with global-land coverage, two times every 12 days.

- 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 Ground Receiving Network



- 41 Tbits / day total L+S band science data downlink

Nominal Ecosystem Cal/Val sites



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

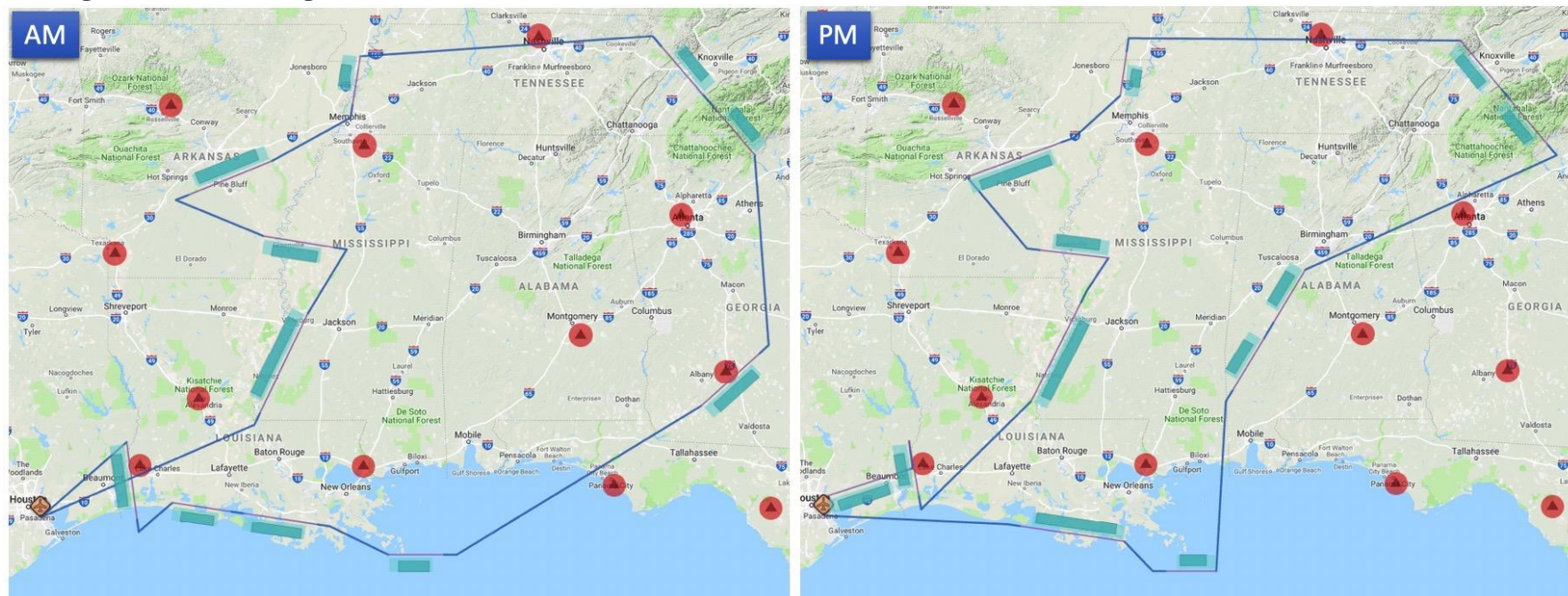


NISAR Ecosystems/Hydrology Status & Upcoming Events

- Status
 - ATBD and Cal/Val plans completed but now being re-reviewed
 - ATBD's being encoded into Jupyter notebooks
 - Workshops in all disciplines completed in recent years
- UAVSAR AM/PM Campaign is **complete**
- ASAR Campaign
 - L + S band airborne SAR provided by ISRO
 - Data collections in the US
- NISAR Land Data Products
 - Soil Moisture global data product
 - SLC data distributed by ASF. Available within 30 days of collection, or (likely) much sooner
 - 20m HDF5 products of HH, HV power in UTM/MGRS
 - All ground-projected data to be radiometrically terrain corrected (RTC)



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
- fData collected between June and October (12 nominal repeat)

Site Name	AM	PM	Total	Success rate AM	Success rate PM	Success rate overall
Total # of flights	9	8	17			
Wax lake Delta	7	6	13	78%	75%	76%
Lenoir Landing (LENO)		7	7		88%	88%
Talledega (TALL)		7	7		88%	88%
Coweeta LTER	7	7	14	78%	88%	82%
ORNL	7	6	13	78%	75%	76%
AR2 and FM3	6	6	12	67%	75%	71%
Stoneville, MS	7	6	13	78%	75%	76%
Yucatan Lake	5	7	12	56%	88%	71%
FM1 and Subsidence	7	7	14	78%	88%	82%
Subsidence TX		5	5		63%	63%
AR1	7	4	11	78%	50%	65%
Tifton	7		7	78%		78%
Oil Spill	7	5	12	78%	63%	71%
White Lake	8		8	89%		89%
Totals	75	73	148	76%	76%	77%

NASA

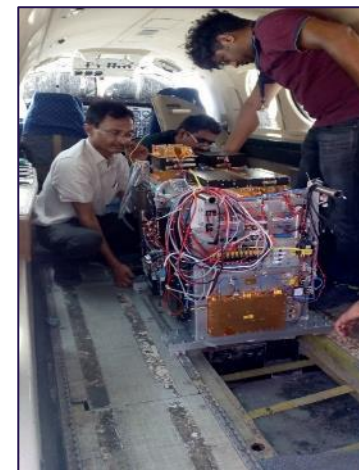
- NASA provides a C-20A (Gulfstream-III) aircraft, a radar instrument pod, and the navigation package
- NASA collects L+S band SAR data from ISRO's ASAR instrument. When possible, NASA's UAVSAR system will co-collect imagery over a common scientific targets
- Collaborate with ISRO investigators on the scientific analysis of the ISRO L- and S-band ASAR data.

ISRO

- ISRO provides L+S band Airborne Synthetic Aperture Radar (ASAR), payload structure, data processing equipment
- Process ASAR instrument data acquired during the campaigns to generate scientific data products (Level 0, 1 & 2)
- Collaborate with NASA investigators on the scientific analysis of the ISRO L- and S-band ASAR data.

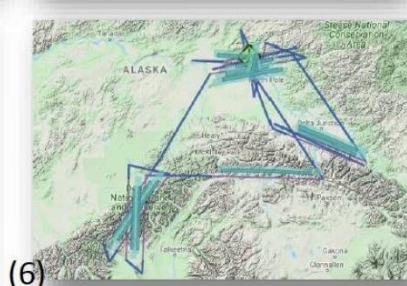
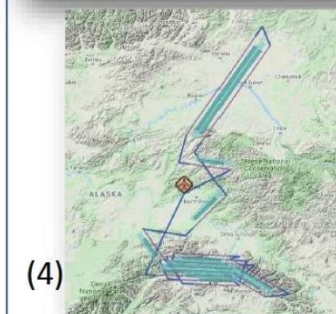
Gulfstream
G-III

UAVSAR
pod



ISRO ASAR Antenna that will be mounted in the UAVSAR pod

- Flight campaign to occur in three phases
- First phases completed in December 2019
- Data being evaluated and delivered now



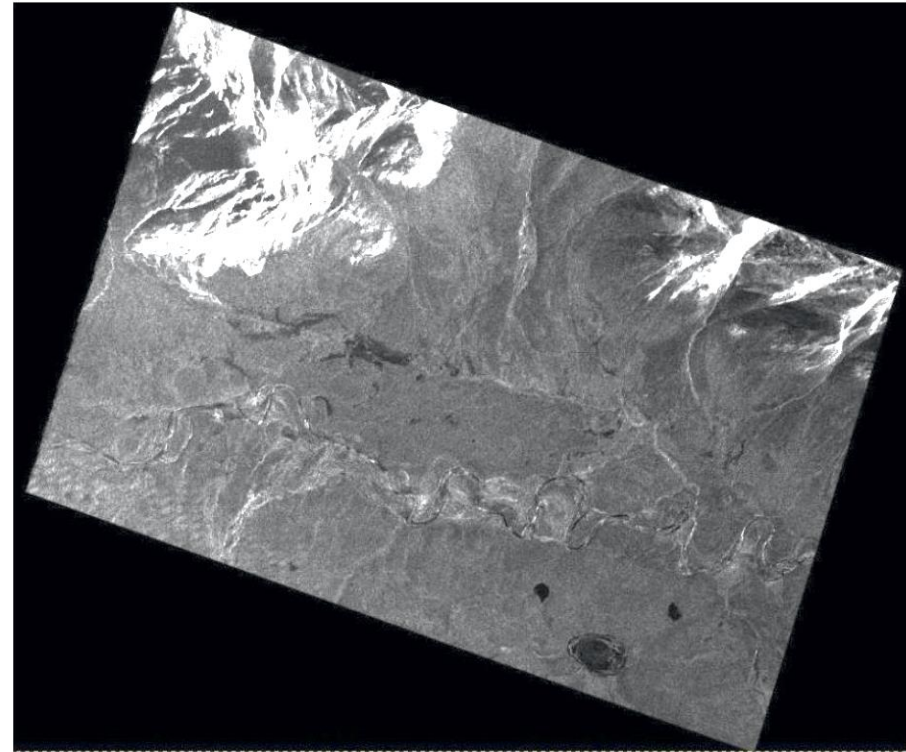
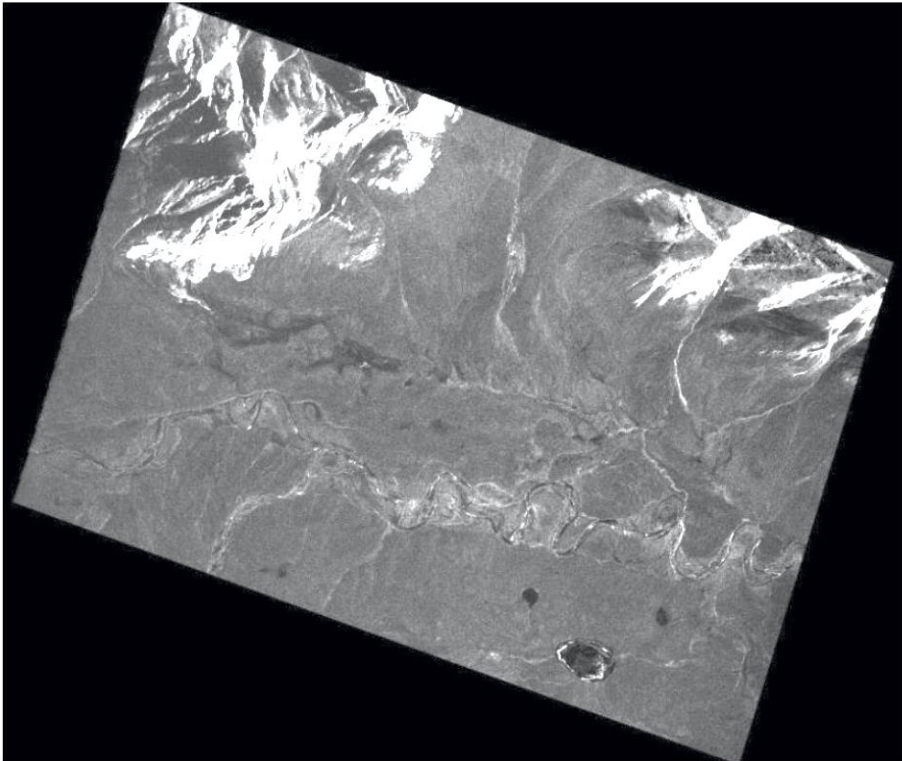
SN	Date	Lines	Area Covered
1	4-Dec-2019	11/12	CA
2	5-Dec-2019	14/16	CA
3	9-Dec-2019	2/2	Palmdale to Fairbanks
4	10-Dec-2019	10/12	Alaska
5	11-Dec-2019	12/12	Alaska
6	12-Dec-2019	14/13	Alaska
7	14-Dec-2019	7/7	Alaska
8	15-Dec-2019	6/6	Nr Seattle
9	16-Dec-2019	13/13	Portland to Palmdale

2TB+2TB = 4TB Data collected in L+S Band

December 14, 2019 -- Alaska

S-band

L-band



Polarization - VV



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NISAR

Applications



Ecosystem

White Papers

[Fire Management](#) (PDF, 1.78 MB)

[Food Security](#) (PDF, 1.01 MB)

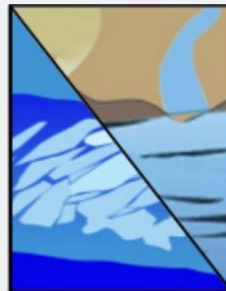
[Forest Resources](#) (PDF, 2.02 MB)

[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)

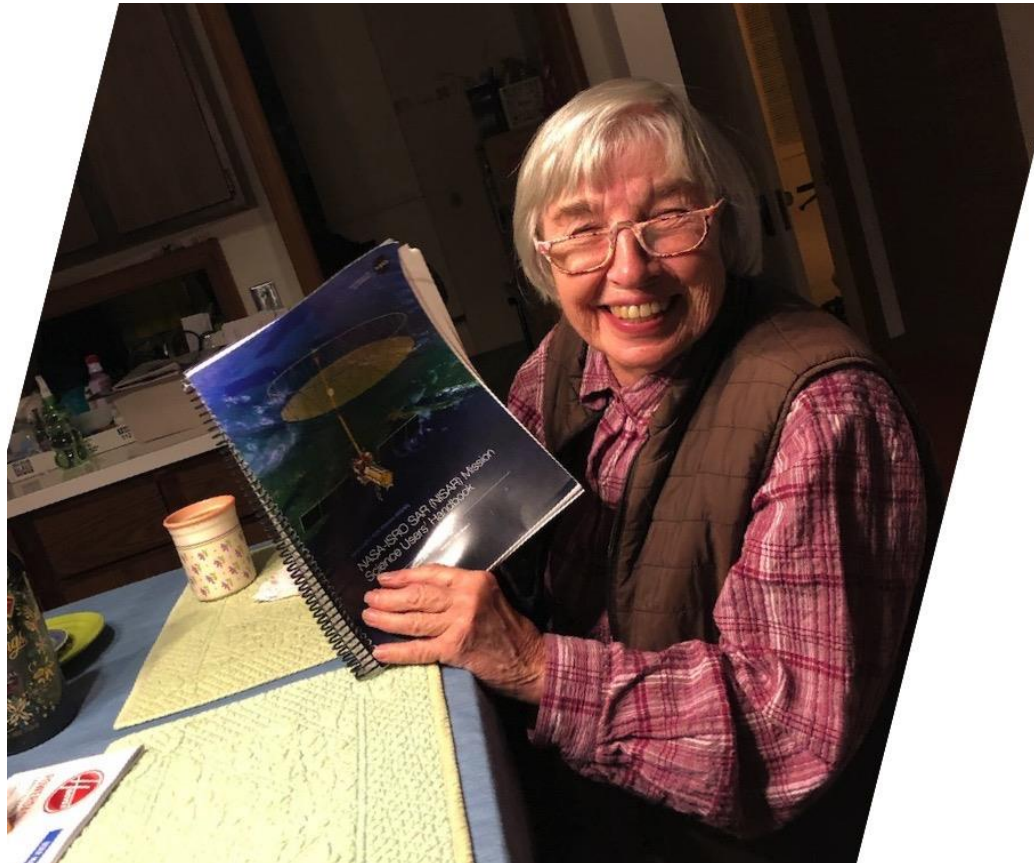
[Marine Hazards](#) (PDF, 1.44 MB)

[Sea Ice](#) (PDF, 2.21 MB)

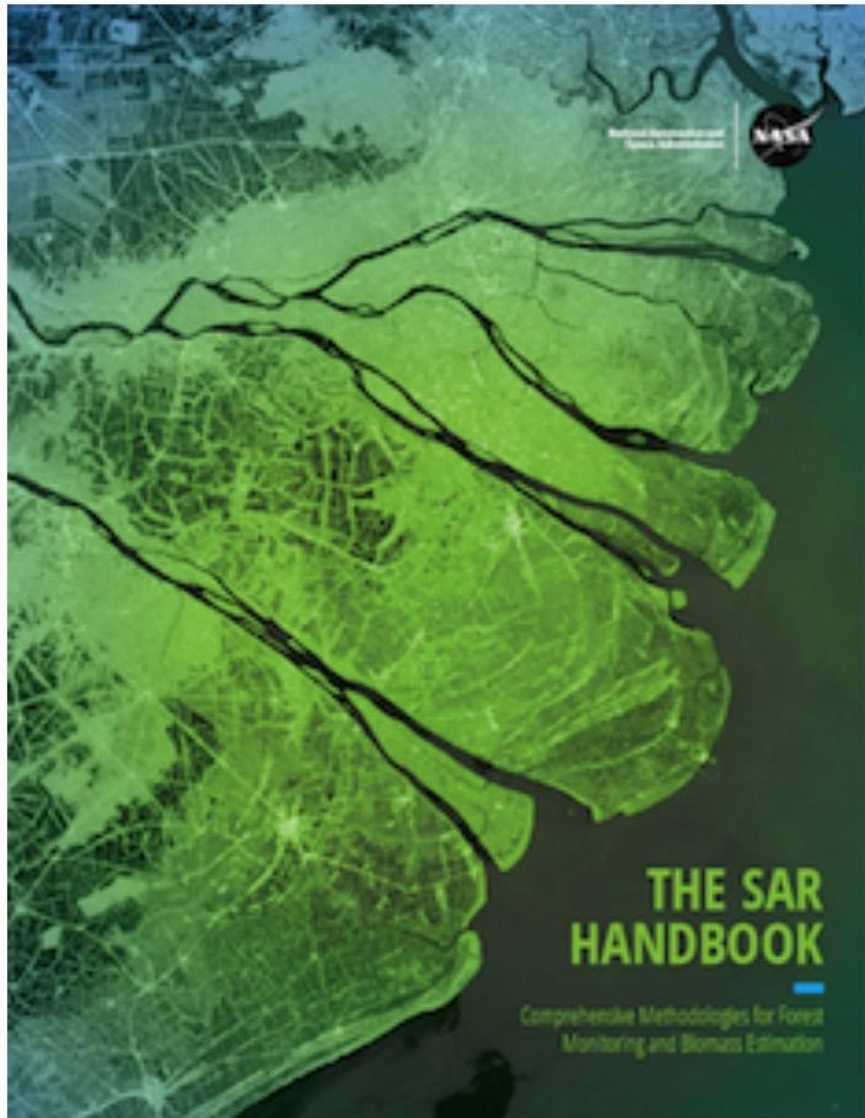
Workshop reports

[Sea Ice and Ocean Applications Workshop Report \(June 2017\)](#)

- NISAR 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!

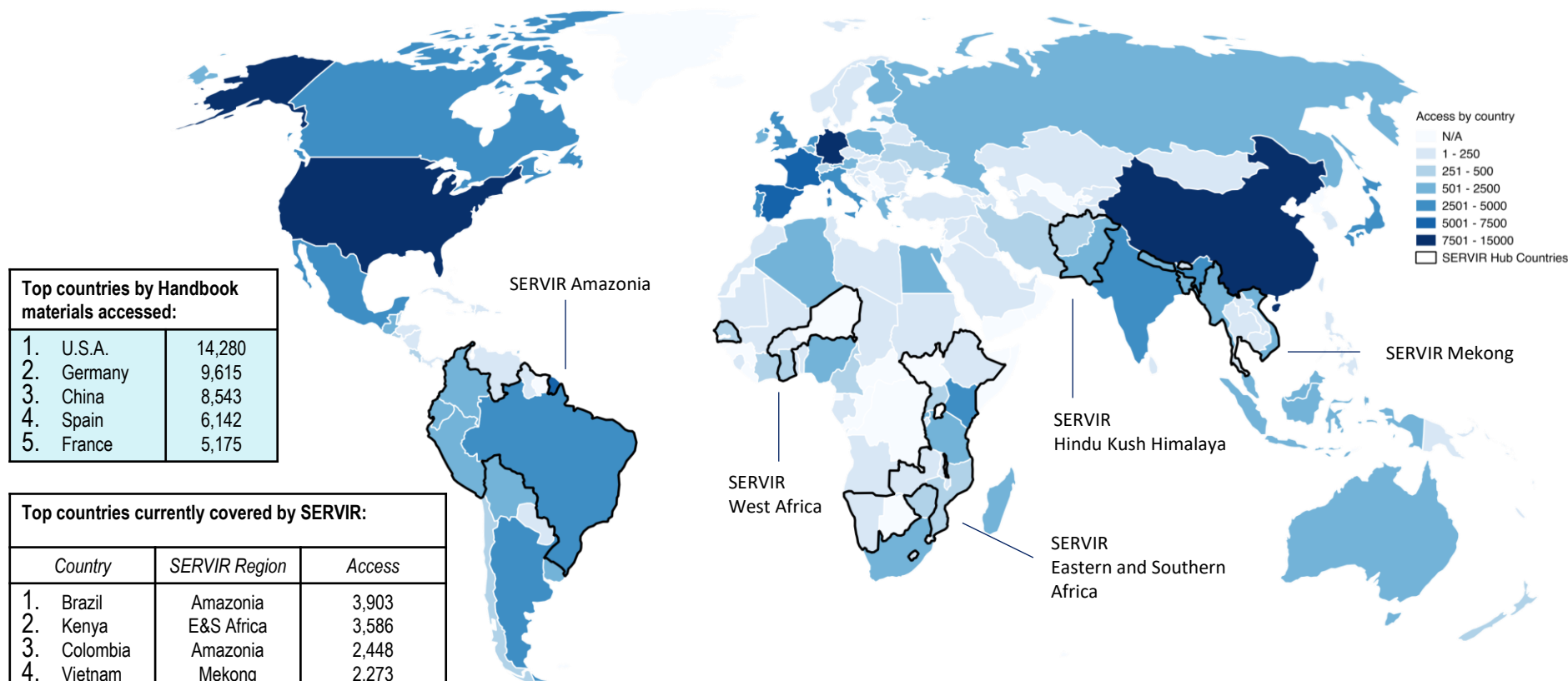


The SAR Handbook Forest Monitoring & Biomass Estimation



- 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

SAR Handbook Materials Have Had Global Reach



Between April 10 – May 5, 2019

- The full Handbook has been accessed more than **103,000** times
- Full Handbook and additional materials have been accessed more than **136,000** times
- **149** countries have accessed SAR Handbook and complementary materials