

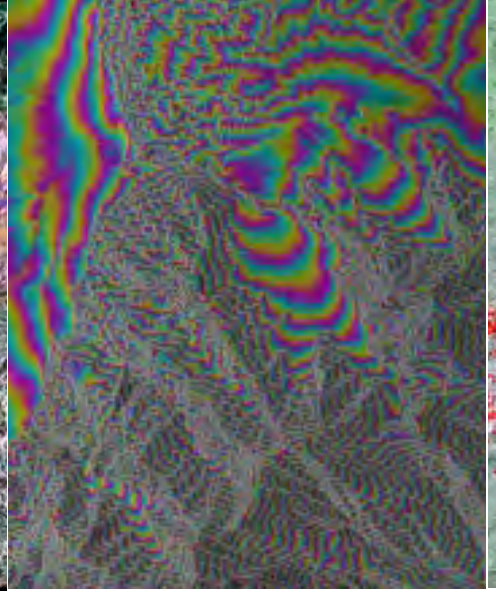


The NISAR Mission – Sensors & Mission Perspective

Paul A Rosen
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ISPRS TC V Mid Term Symposium
Indian Institute of Remote Sensing, Dehradun, India
November 20th, 2018

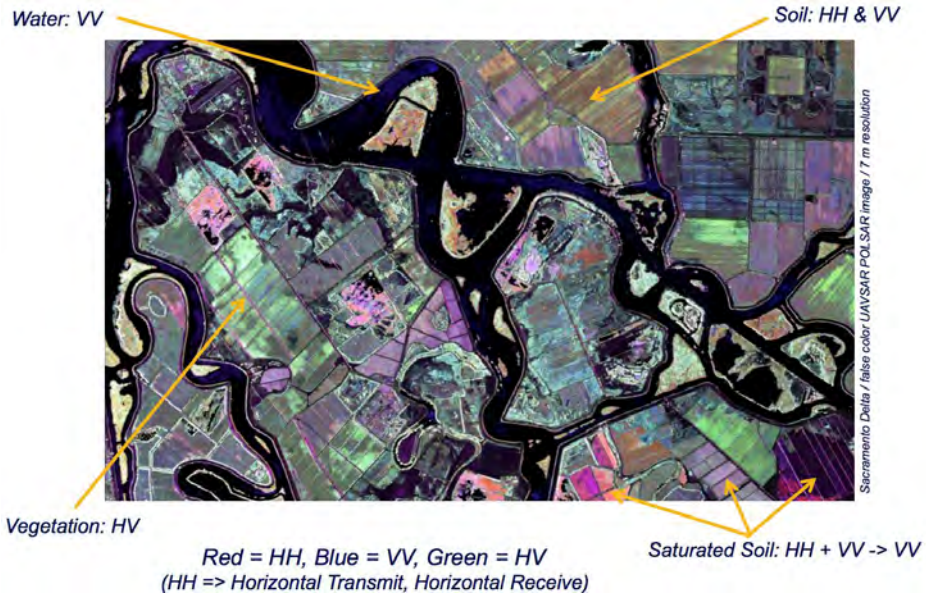
Jet Propulsion Laboratory
California Institute of Technology

NISAR – NASA Science Focus

Capturing the Earth in Motion

NISAR will image Earth's dynamic surface over time, providing information on changes in ice sheets and glaciers, the evolution of natural and managed ecosystems, earthquake and volcano deformation, subsidence from groundwater and oil pumping, and the human impact of these and many other phenomena.

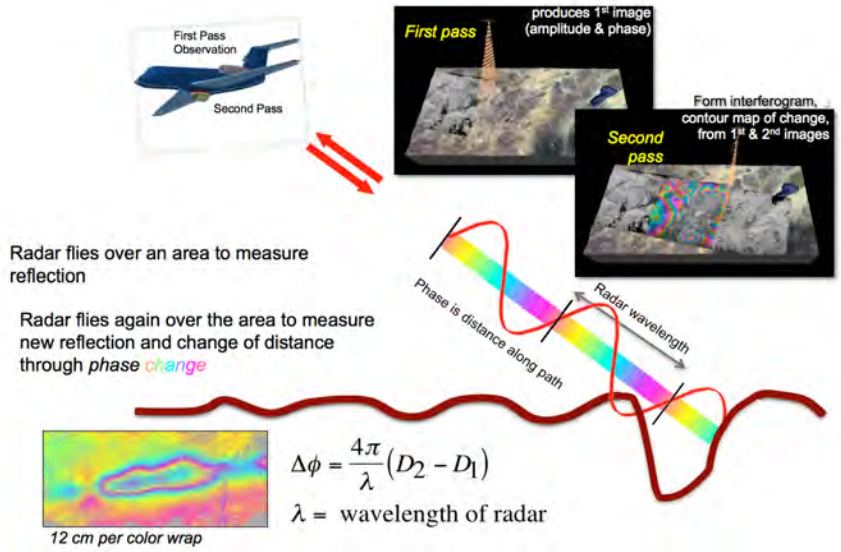
Versatility of SAR for Studying Earth Change



Polarimetric SAR
Use of polarization to determine surface properties

Applications:

- **Flood extent (w/ & w/o vegetation)**
- **Land loss/gain**
- **Coastal bathymetry**
- **Biomass**
- **Vegetation type, status**
- **Pollution & pollution impact (water, coastal land)**
- **Water flow in some deltaic islands**



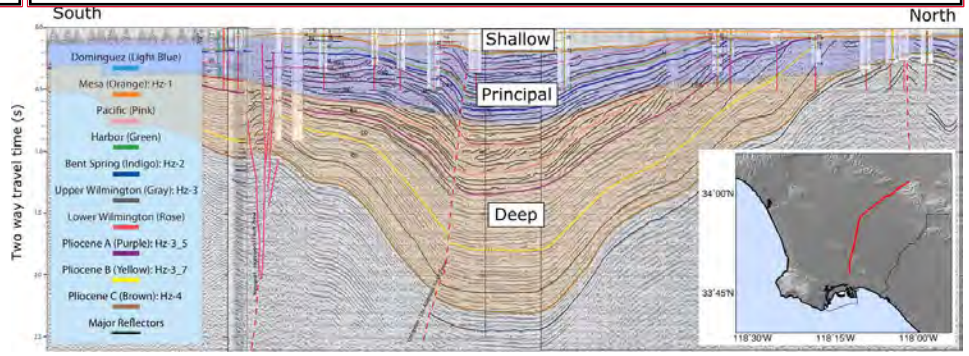
Interferometric SAR
Use of phase change to determine surface displacement

Applications:

- **Geophysical modeling**
- **Subsidence due to fluid withdrawal**
- **Inundation (w/vegetation)**
- **Change in flood extent**
- **Water flow through wetlands**

Earth's Dynamic Subsurface

- Data ➔18-year time series (881 igrams) + GPS + Hydraulic head from observation wells + geologic structure model
- Spatial pattern of seasonal ground deformation near the center of the basin corresponds to a diffusion process with peak deformation occurring at locations with highest groundwater production.
- Seasonal ground deformation associated with shallow aquifers used for the majority of groundwater production
- Long-term ground deformation over broader areas - correlated with delayed compaction of deeper aquifers and potential compressible clay layers.



Quantifying Ground Deformation in the Los Angeles and Santa Ana Coastal Basins Due to Groundwater Withdrawal, B. Riel et al., *Water Resources Res.*, **54**, doi:10.1029/2017WR021978, 2018.

Courtesy: M. Simons, B. Riel (Caltech)

NASA-ISRO SAR (NISAR) Mission

Jet Propulsion Laboratory
California Institute of Technology

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

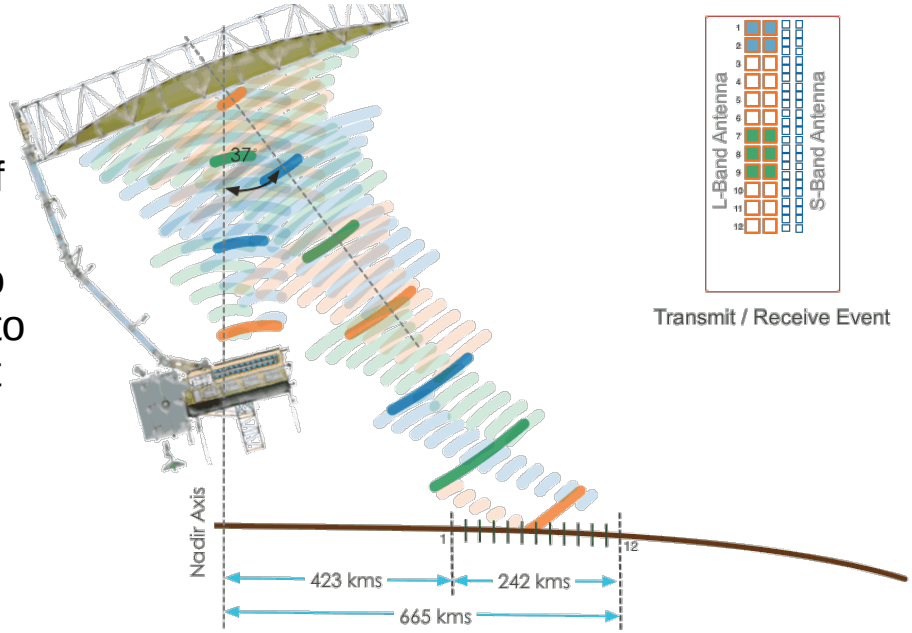
NISAR Characteristic:	Enables:
L-band (24 cm wavelength)	*Low temporal decorrelation and foliage penetration*
S-band (9 cm wavelength)	*Sensitivity to lighter vegetation*
SweepSAR technique with Imaging Swath > 240 km	*Global data collection*
*Polarimetry (Single/**Dual**/Quad)*	*Surface characterization and biomass estimation*
12-day exact repeat	*Rapid Sampling*
3 – 10 meters mode-dependent SAR resolution	*Small-scale observations*
Pointing control < 273 arcseconds	*Deformation interferometry*
Orbit control < 500 meters	*Deformation interferometry*
***L**/**S**-band > **50**/**10**% observation duty cycle*	*Complete land/ice coverage*
Left-only pointing (Left/Right capability)	*Uninterrupted time-series Rely on Sentinel-1 for Arctic*

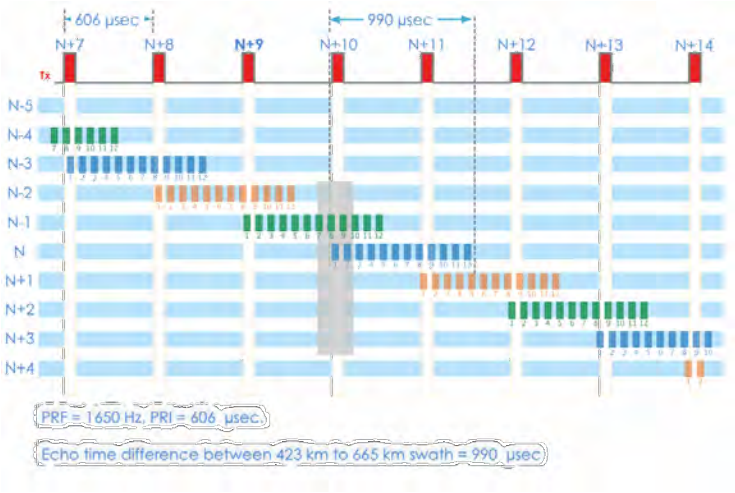
Planned Launch: December 2021

Measurement Technique

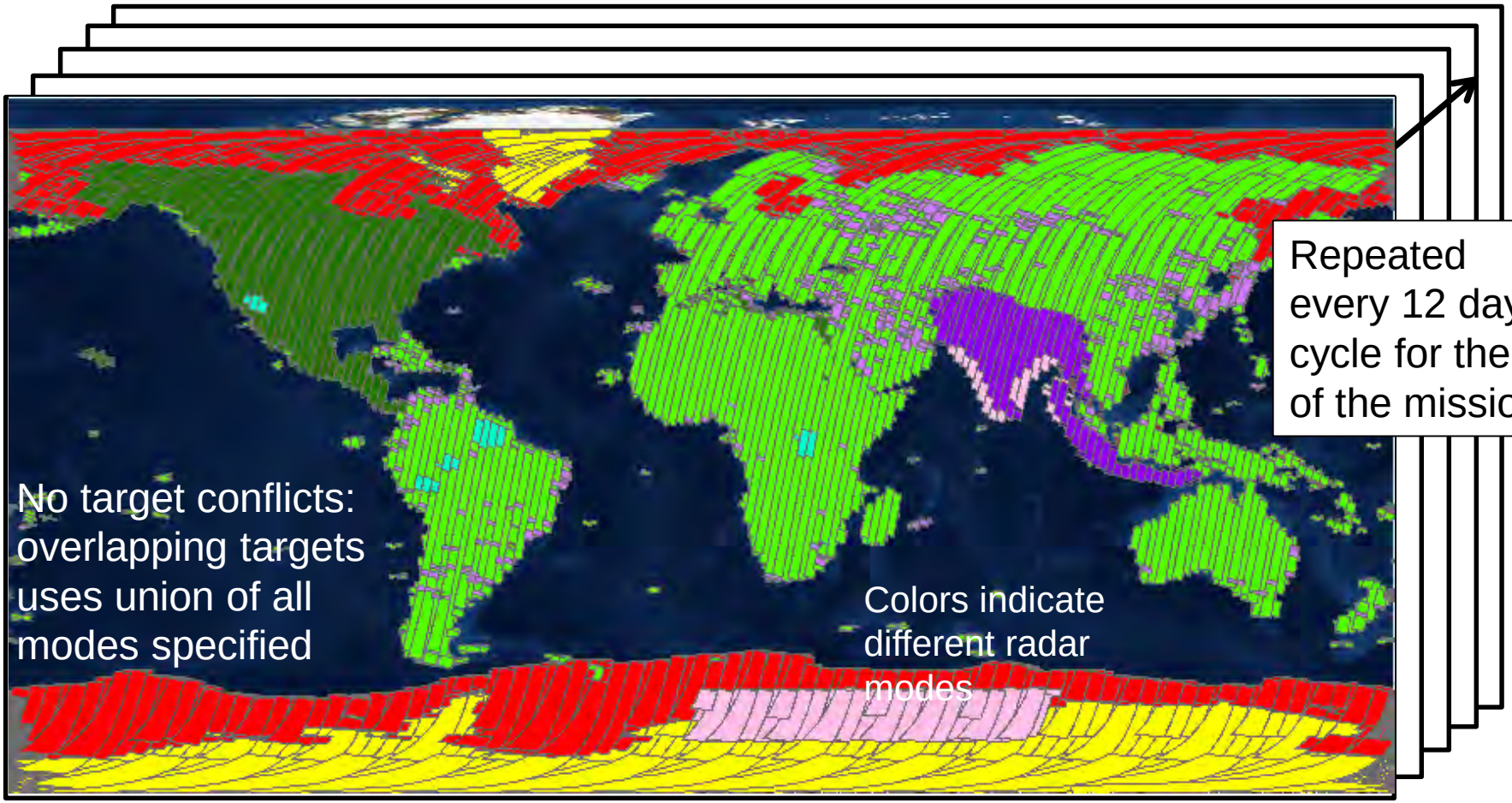
Instrument Concept

- **SweepSAR**
  - On Transmit, illuminate the entire swath of interest
  - On Receive, steer the beam in fast time to follow the angle of the echo coming back to maximize the SNR of the signal and reject range ambiguities
  - Allows echo to span more than 1 Inter-Pulse Period (IPP)
- **Consequences**
  - 4 echoes can be simultaneously returning to the radar from 4 different angles in 4 different groups of antenna beams
  - Each echo needs to be sampled, filtered, beam-formed, further filtered, and compressed
  - On-board processing is not reversible – Requires on-board calibration before data is combined to achieve optimum performance





NISAR Systematic Observations



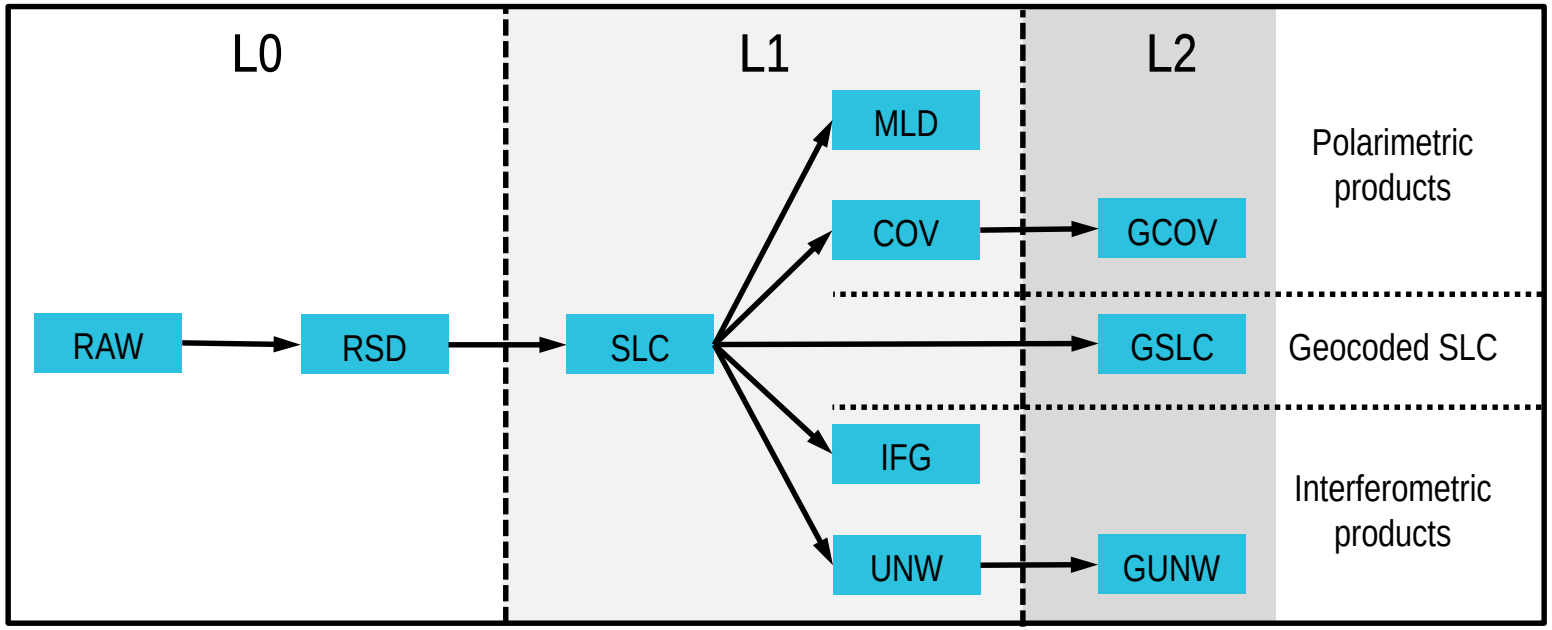
J. Doubleday
P. Sharma, JPL

Persistent updated measurements of Earth
41 Tbits / day total L+S band science data downlink
120 Tbytes / day total L+S band L0-L2 data products

NISAR - NASA's Global Product Suite

Toward data democracy

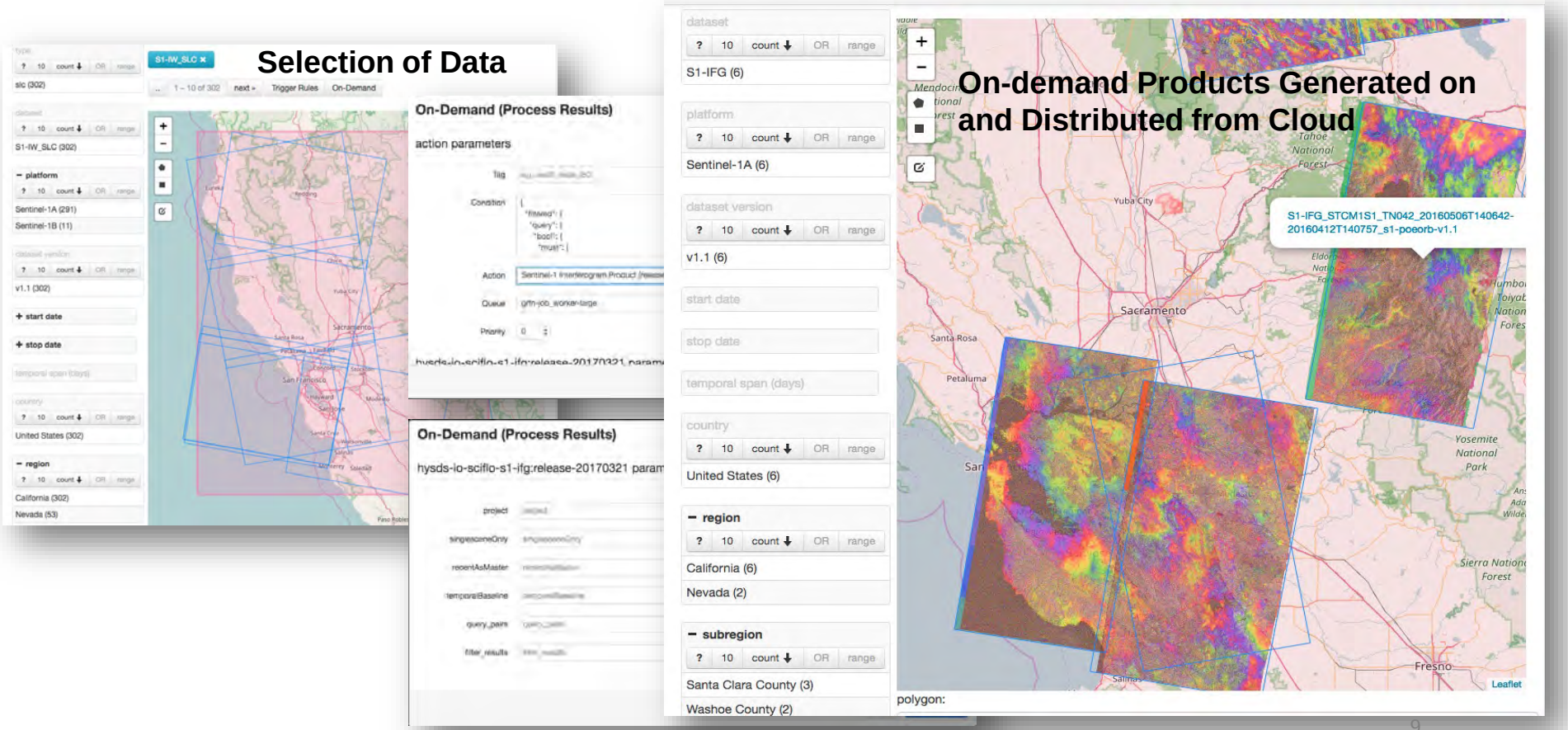
- 26-35 Tbits of raw L-band data per day on average
- 3-6 Tbits of raw S-band data per day on average
- L-SAR L0a, L0b, L1, and L2 science products
- S-SAR L0 science product of data downlinked through NASA Ka-band
- ***Free and open archive in Alaska Satellite Facility DAAC***



Data Processing and Access Moving to the Cloud

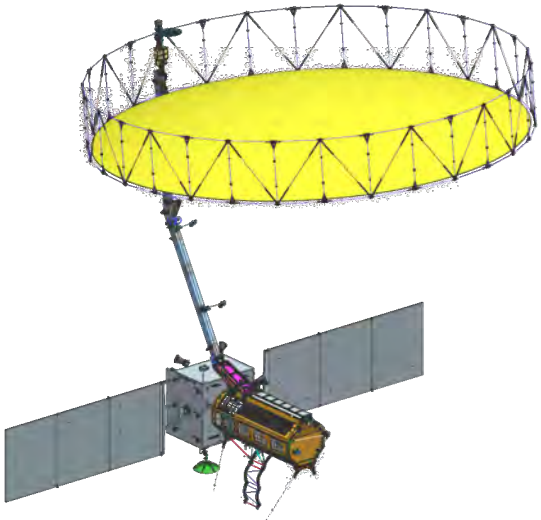
Toward Data Democracy

- Cloud Processing and distribution allows scalability and localization with users
- On-demand processing allows users to satisfy their needs without high-capability computing and networks.
- Prototyped with ARIA/GRFN Cloud Processing System

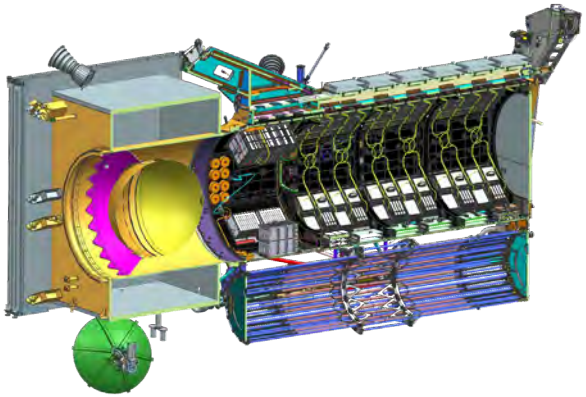


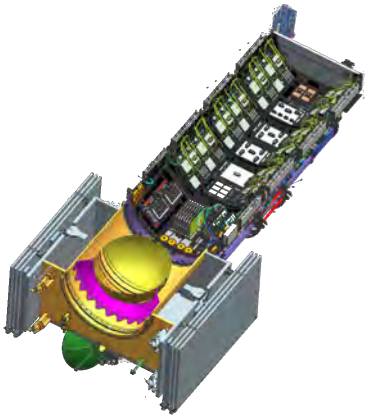
NISAR Observatory

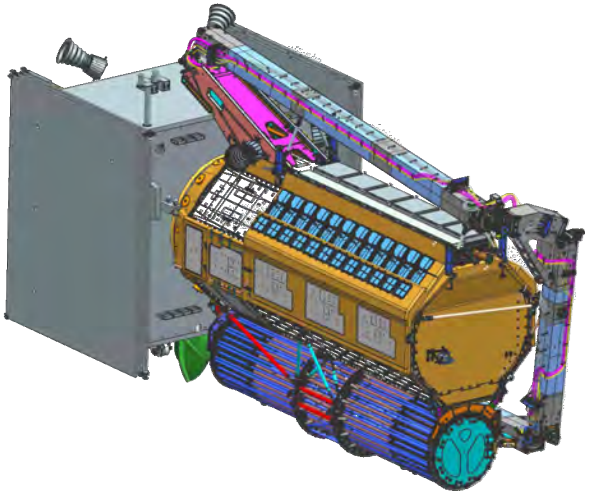
JPL and ISRO have made significant progress toward building the NISAR observatory



Deployed Configuration







Stowed Configuration

NISAR

Current Status

- Successful Critical Design Review in October 2018
- All Engineering Models, some Flight Models built
- Launch Readiness Date December 2021
- Science Team reached consensus on a left-only observation plan
  - Shifts launch to Jan 2022
  - Would forgo Arctic coverage above 77.5 deg N in favor of continuous time series, greater Antarctic coverage
  - Relies on Sentinel-1 Program of Record to complete coverage
  - Would be the first (?) example of optimizing the international SAR constellation for science

Beyond NISAR

2017 NASA Earth Science Decadal Survey

- Recommended “designated” observations, addressing five of the highest-priority Earth observation needs
  - Considered foundational elements of the decade’s observing plan
- One of the five: Earth surface dynamics from earthquakes and landslides to ice sheets and permafrost
  - Suggested spaceborne InSAR as measurement technique
  - Recommends faster sampling than NISAR
  - NASA desires capability for other disciplines as well.

NASA looking for strong international cooperation to create an extended observing system

Science Users' Handbook

https://nisar.jpl.nasa.gov/files/nisar/NISAR_Science_Users_Handbook1.pdf

Describes:

- Science and Applications
- Mission Science Requirements
- Mission Design and CONOPS
- Flight System Characteristics
- Radar and Measurement Principles
- Data Products
- Will be revised prior to launch or as necessary

Other major documents:

- Cal/Val Plan
- Utilization Plan
- Application Workshop Reports
- 21 science and applications white papers

NISAR Community Training

NASA invests in coordinated SAR/InSAR/PolSAR training materials

- Applied Remote Sensing Training (ARSET) program
- SERVIR Training Programs
- UNAVCO ISCE/GIAnT annual classes
- Participation in PolSARPro development and training
- Discipline-specific course development investments
- Workshops to coordinate with international efforts such as SAREDU and EO College