NISAR Science and Applications Overview – US Perspective

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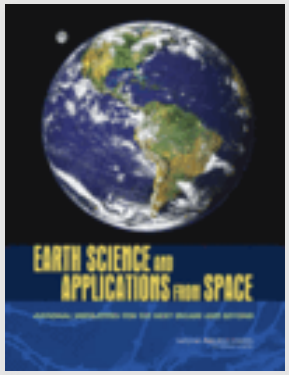
NISAR Science Overview and Program Context

- NRC Decadal Survey recommended a DESDynI Mission for near-term launch to address important scientific questions of high societal impact.
- NASA's Climate Architecture identified the radar's important role in climate (cryosphere and carbon) and water cycle science.



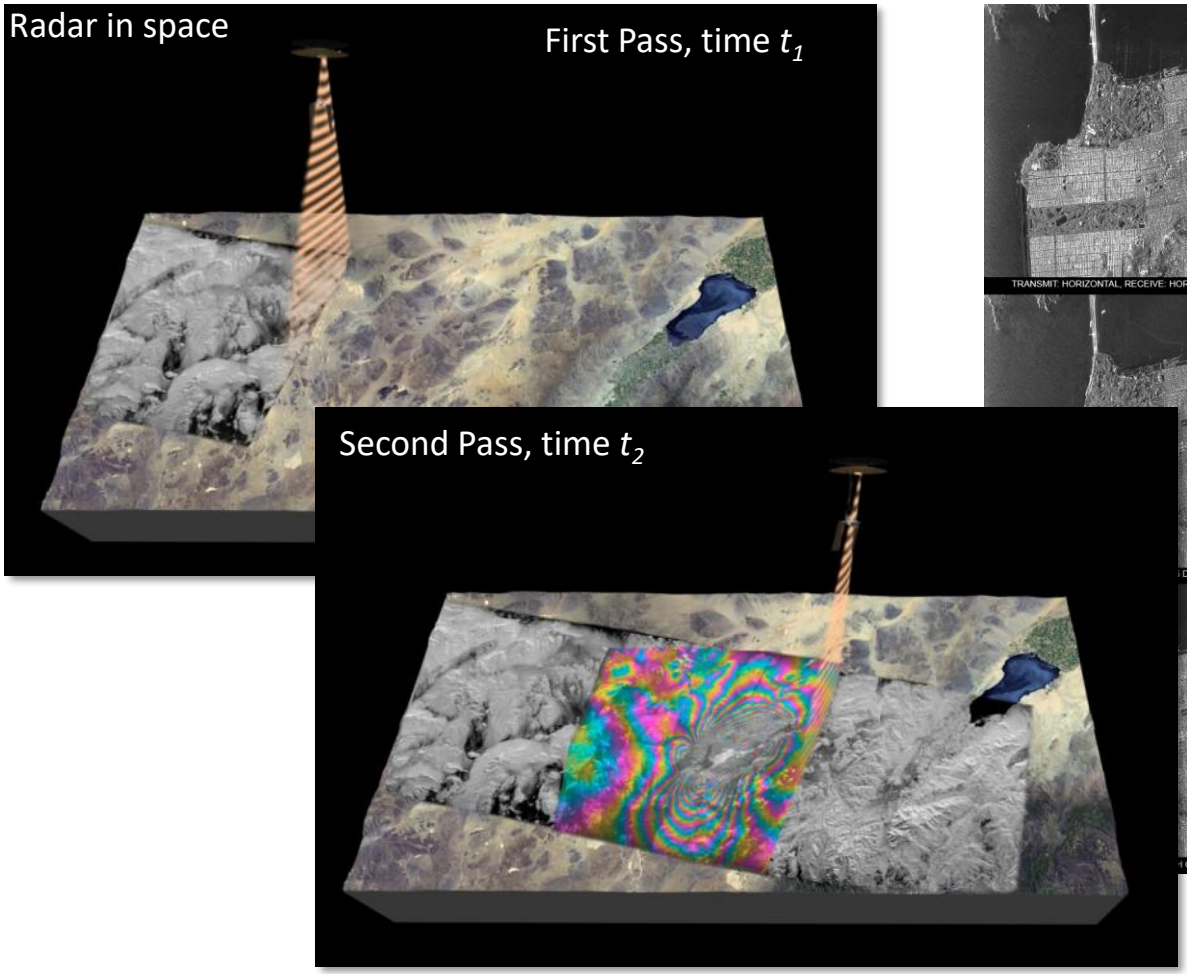
- The NASA NISAR Science Definition Team has developed a set of integrated requirements to respond to the Climate Architecture and other important questions, with ISRO Science participation

- **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?*

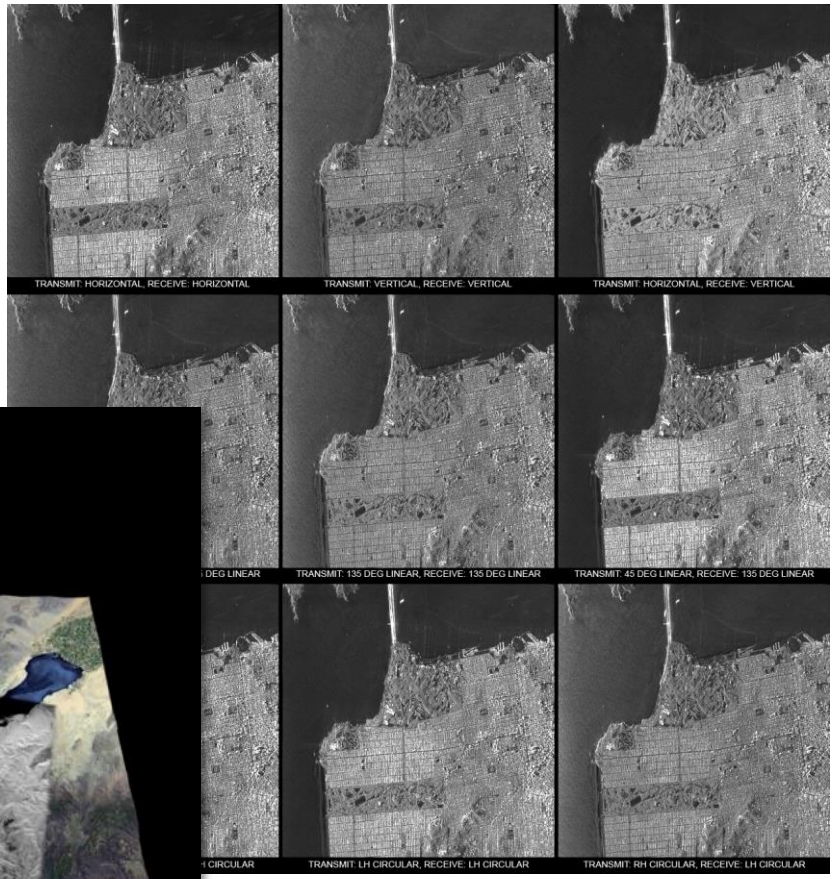
NISAR
NASA - ISRO SAR Mission

NISAR Measurements to Achieve Science Objectives

Repeat Pass Interferometry



Polarimetric Diversity

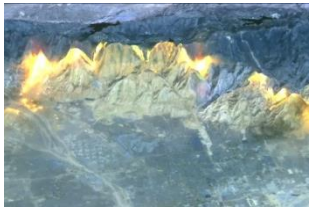


NISAR Mission Overview

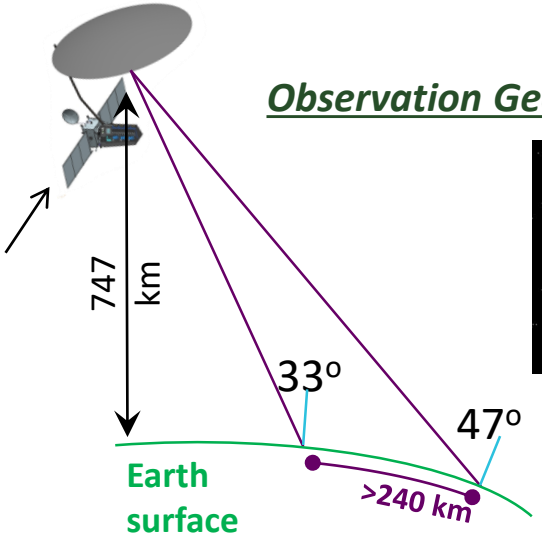
NISAR Characteristic:	Would Enable:
L-band (24 cm wavelength)	Low temporal decorrelation and foliage penetration
S-band (12 cm wavelength)	Sensitivity to light vegetation
SweepSAR technique with Imaging Swath > 240 km	Global data collection
Polarimetry (Single/Dual/Quad)	Surface characterization and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

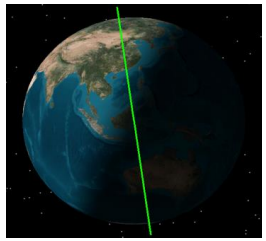
NISAR Will Uniquely Capture the Earth in Motion






Observation Geometry



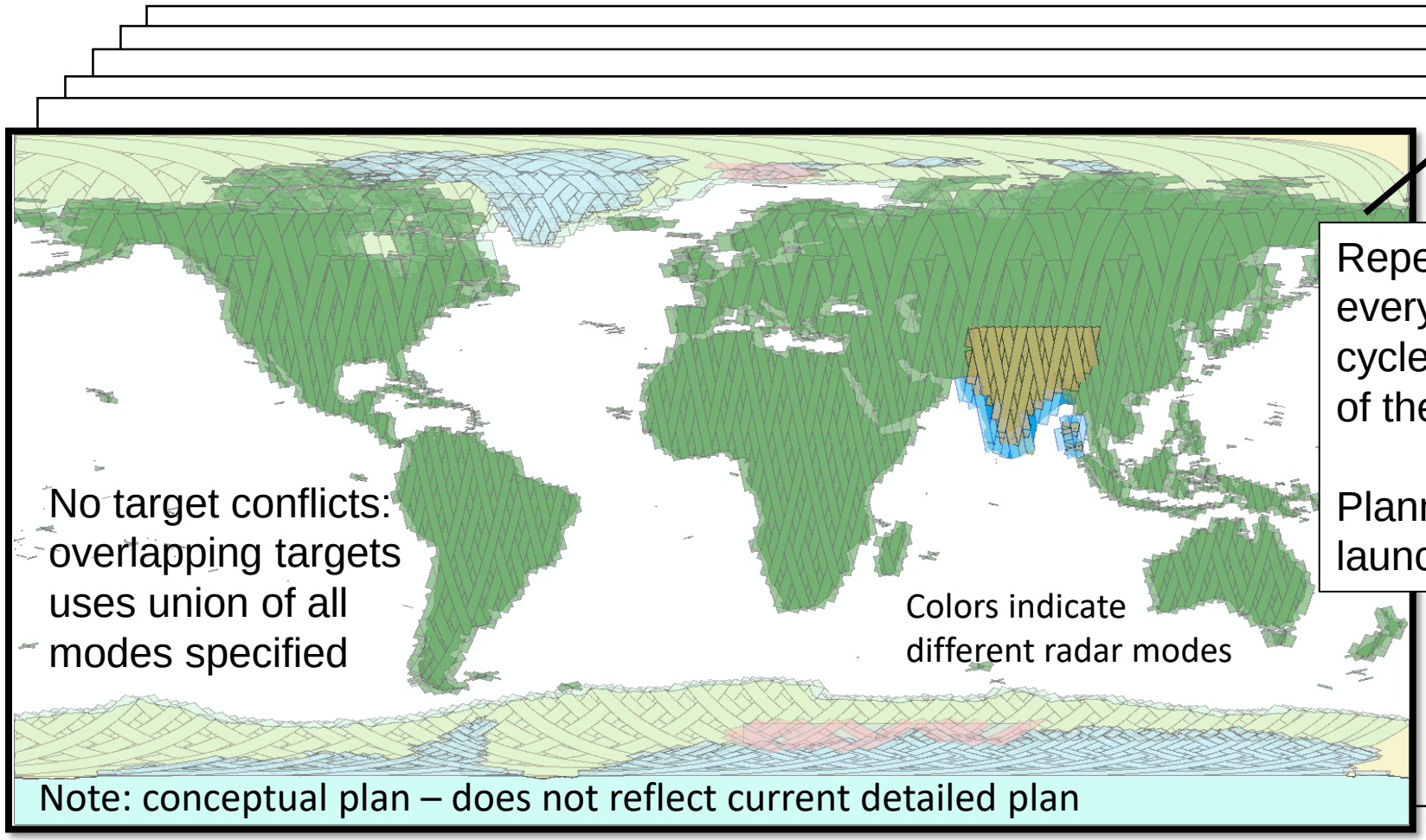


NISAR Science Observing/Operations Modes
Blanket Land and Ice Coverage Every 12 Days

- Observation strategy employs a 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	

NISAR Systematic Observations
L-band globally – S-band selectively



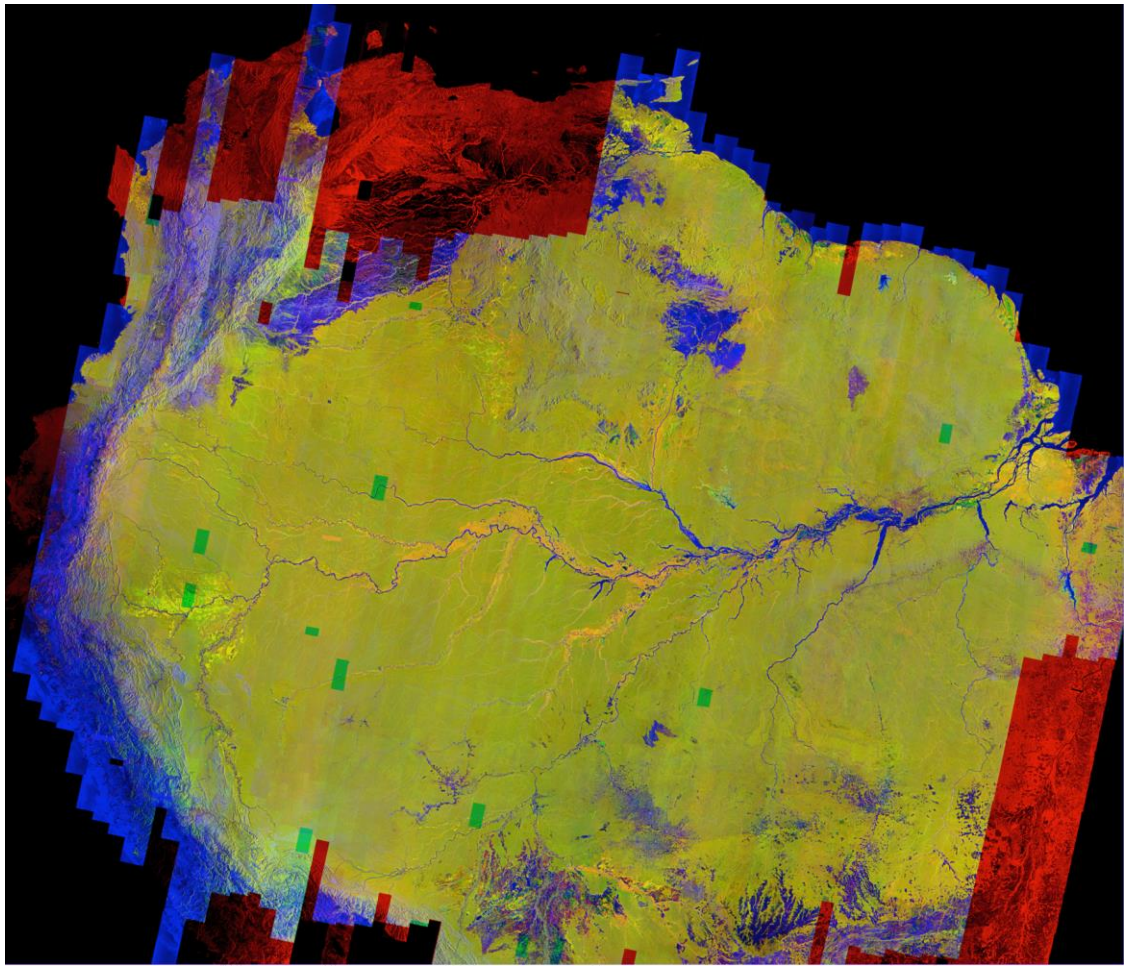
Repeated every 12 day cycle for the life of the mission

Planned launch: 2021

C. Ballard, JPL

Persistent updated measurements of Earth

Measuring the Global Terrestrial Carbon Cycle

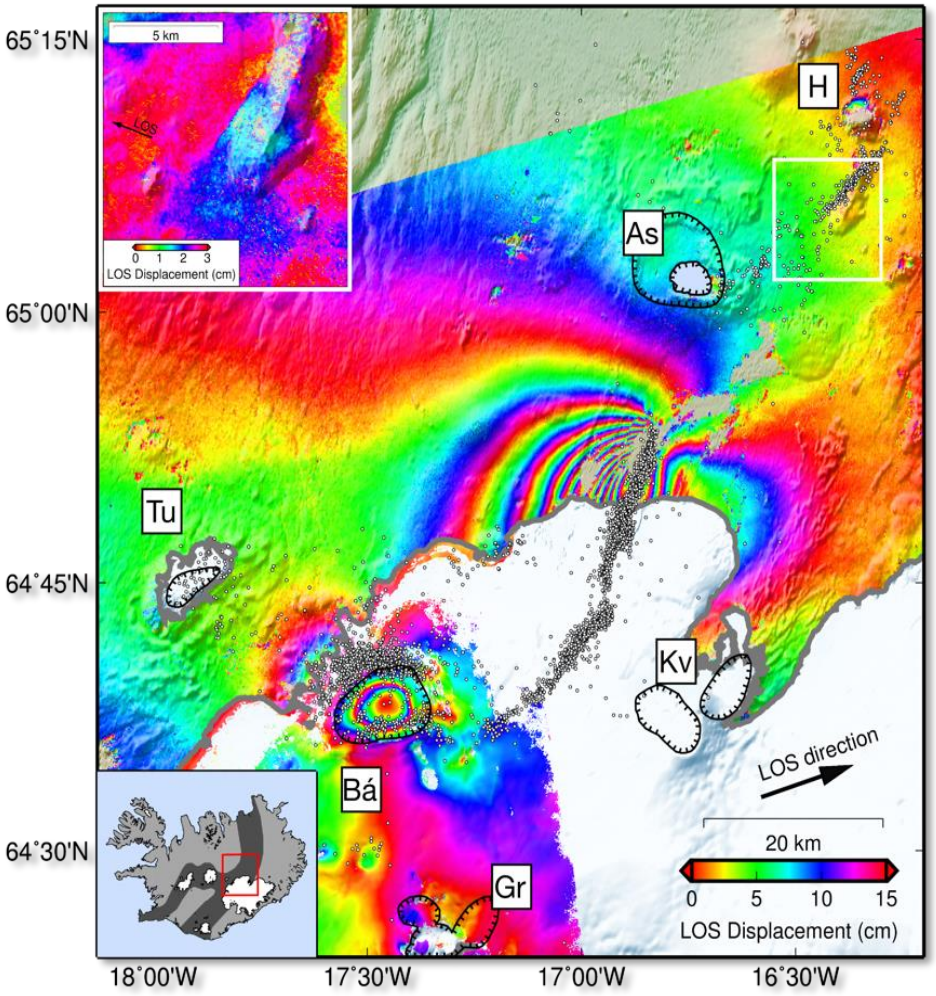


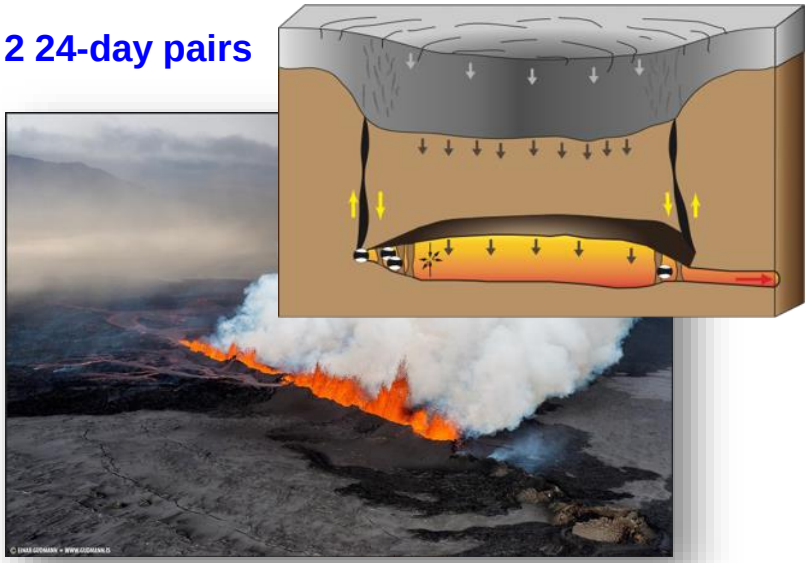
NISAR will measure changes in forests and agricultural globally and seasonally

Measuring Volcanic Activity and Risk Globally

Collapse of Bárdabunga Caldera (Iceland) & associated plate boundary rifting

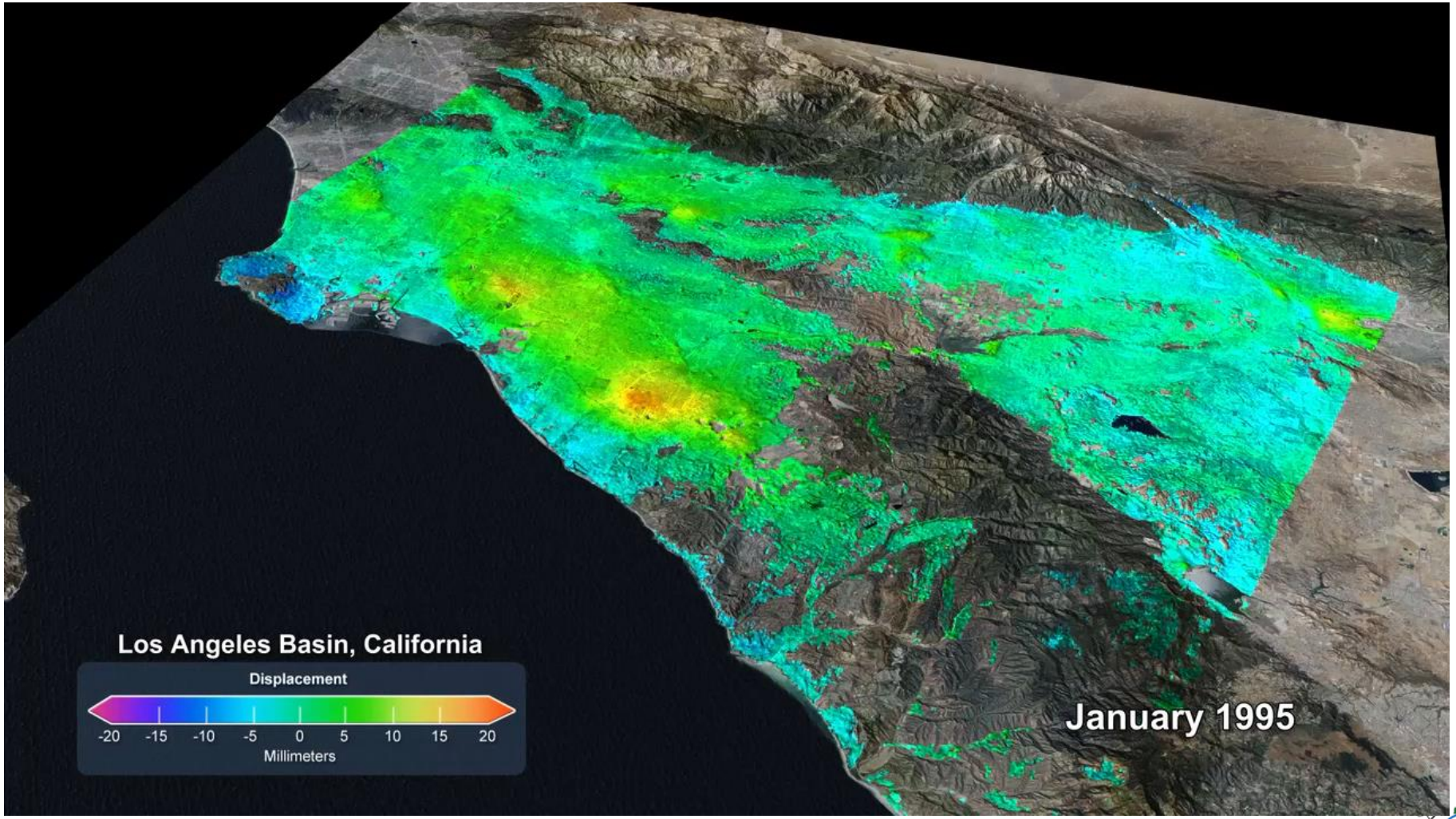
Fast Sampling (COSMO-SkyMed 1-day) fills in Radarsat 2 24-day pairs





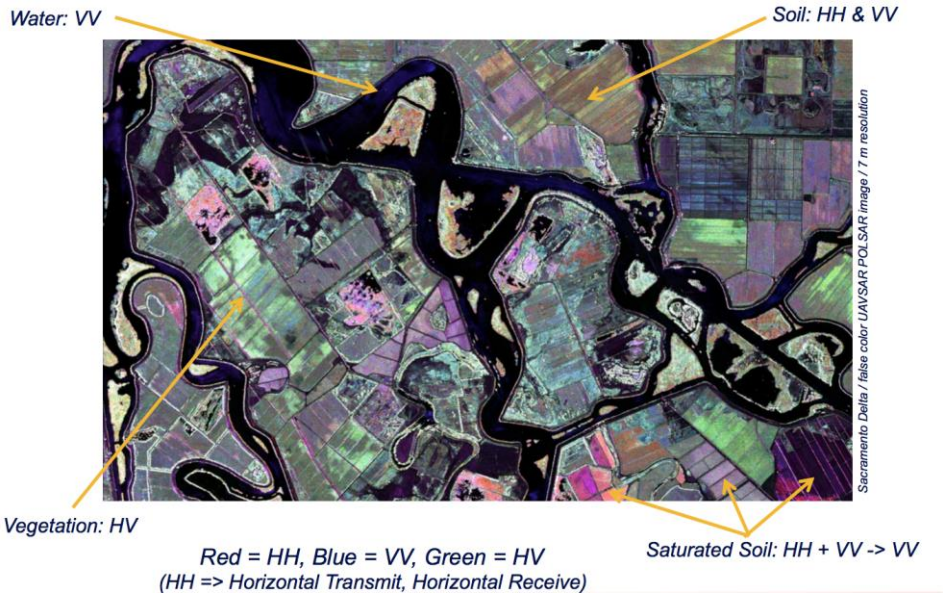
Riel et al., *Geophys. J. Int.*, 2015

Measuring Aquifer Usage Globally



Capturing Ice Dynamics of Earth to Constrain Climate Models

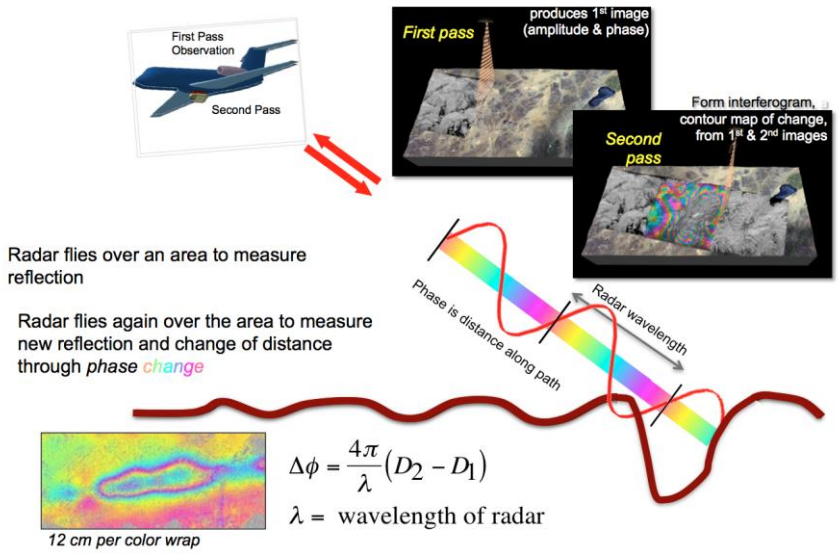
Versatility of SAR: Many Applications



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**

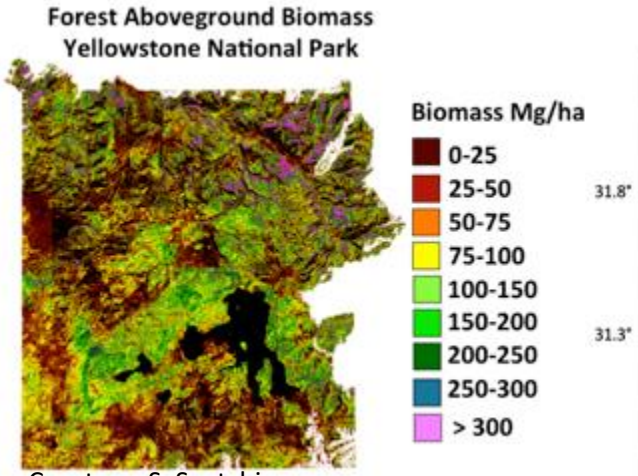


Interferometric SAR
Use of phase change to determine surface displacement

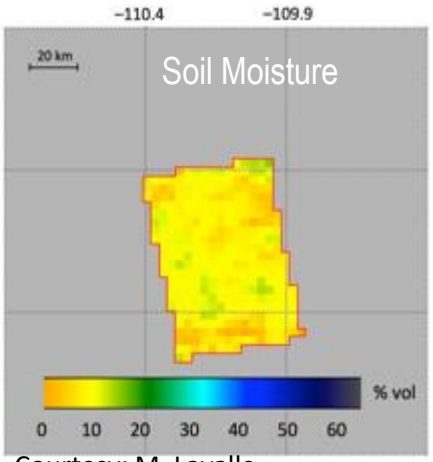
Applications:

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

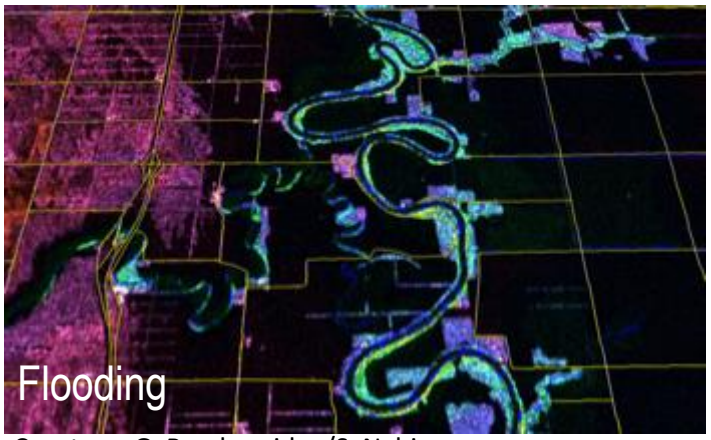
Numerous NISAR Applications Products



Courtesy: S. Saatchi

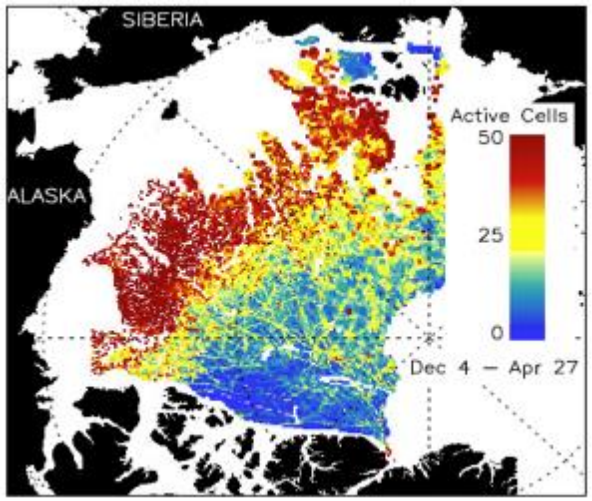


Courtesy: M. Lavalle



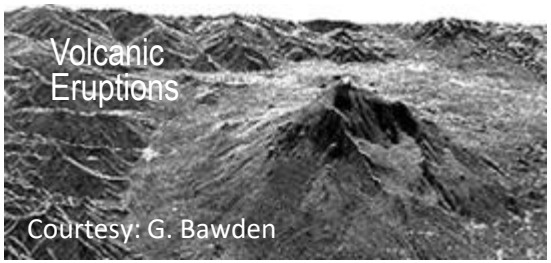
Courtesy: G. Breckenridge/S. Nghiem

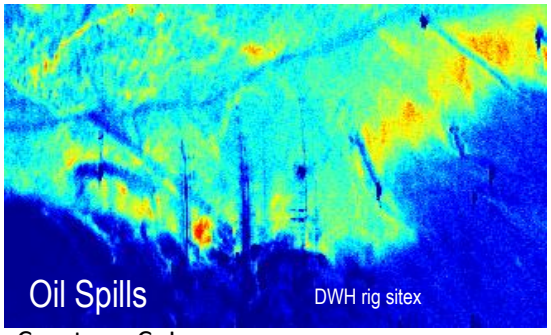
Courtesy: S.-H. Yun



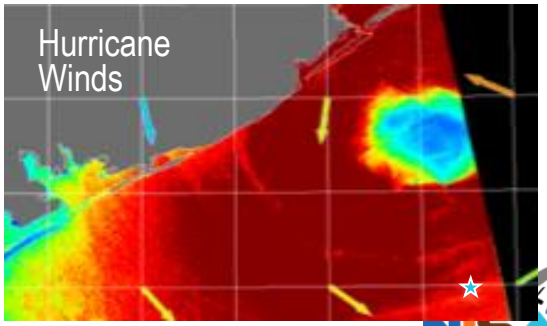
Courtesy: R. Kwok

Sea Ice Extent/ Ice and Ship Tracking





Courtesy: C. Jones



Courtesy: G. Bawden

SAR for Broad Applications

Application	Benefit Through Regular SAR Monitoring of:
Global Food Security	- Soil moisture and crop growth at agricultural scale - Desertification at regional scales
Freshwater Availability	- Aquifer use/extent regionally - Water-body extent changes - Glaciers serving as water sources
Human Health	- Moisture and vegetation as proxy for disease and infestation vectors
Disaster Prediction & Hazard Response	- Regional building damage and change assessment after earthquakes - Earthen dams and levees prone to weakening - Volcanoes, floods, fires, landslides, oil spills
Climate Risks and Adaptation	- Ice sheet/sea-ice dynamics; response to climate change - Coastal erosion & processes and shoreline migration
Urban Management and Planning	- Urban growth through coherent change detection - Building deformation and urban subsidence
Human-activity Based Climate Change	- Deforestation's influence on carbon flux - Oil and gas reservoirs

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Summary

- From US Perspective, NISAR is focused on
  - Global coverage
  - Dense sampling in time
  - Vector measurements
- In order to accomplish new science
  - Global inventory of earthquakes and volcanos (above sea level)
  - Global inventory of biomass changes over the mission
  - Global inventory of wetlands and cultivated agriculture
  - Global dynamics of ice sheets and sea ice
- And to develop a community of applications users for
  - Disaster response
  - Infrastructure monitoring
  - Agriculture and forestry applications
  - A host of others!

Thank you

- Questions?