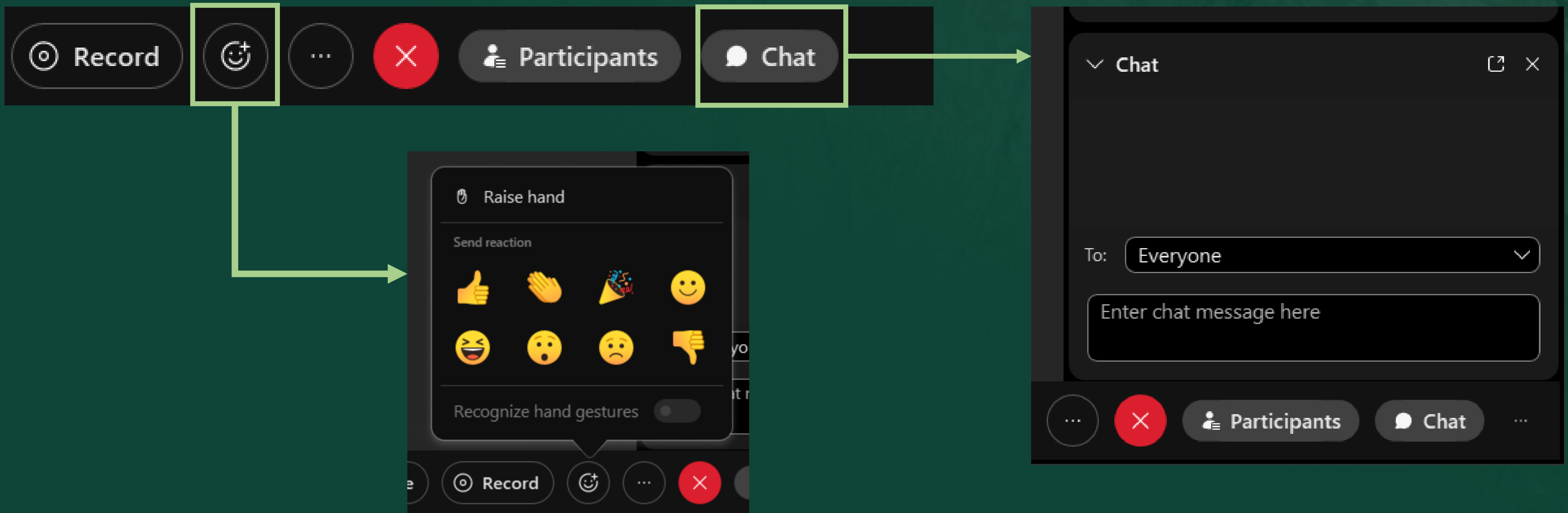
SDC Virtual Community Meeting

Friday, May 13, 2022 – 11 AM EDT to 1:00 PM EDT

- This meeting will be **recorded**, and the recording will be available later the SDC website.

- The first hour or so please input your questions into the WebEx chat panel. We have moderators monitoring them and the SDC team will ask selected questions at the end of the various sections. During the last 45 minutes, moderators will work to unmute those that have questions to ask and have a dialogue with the SDC Team.



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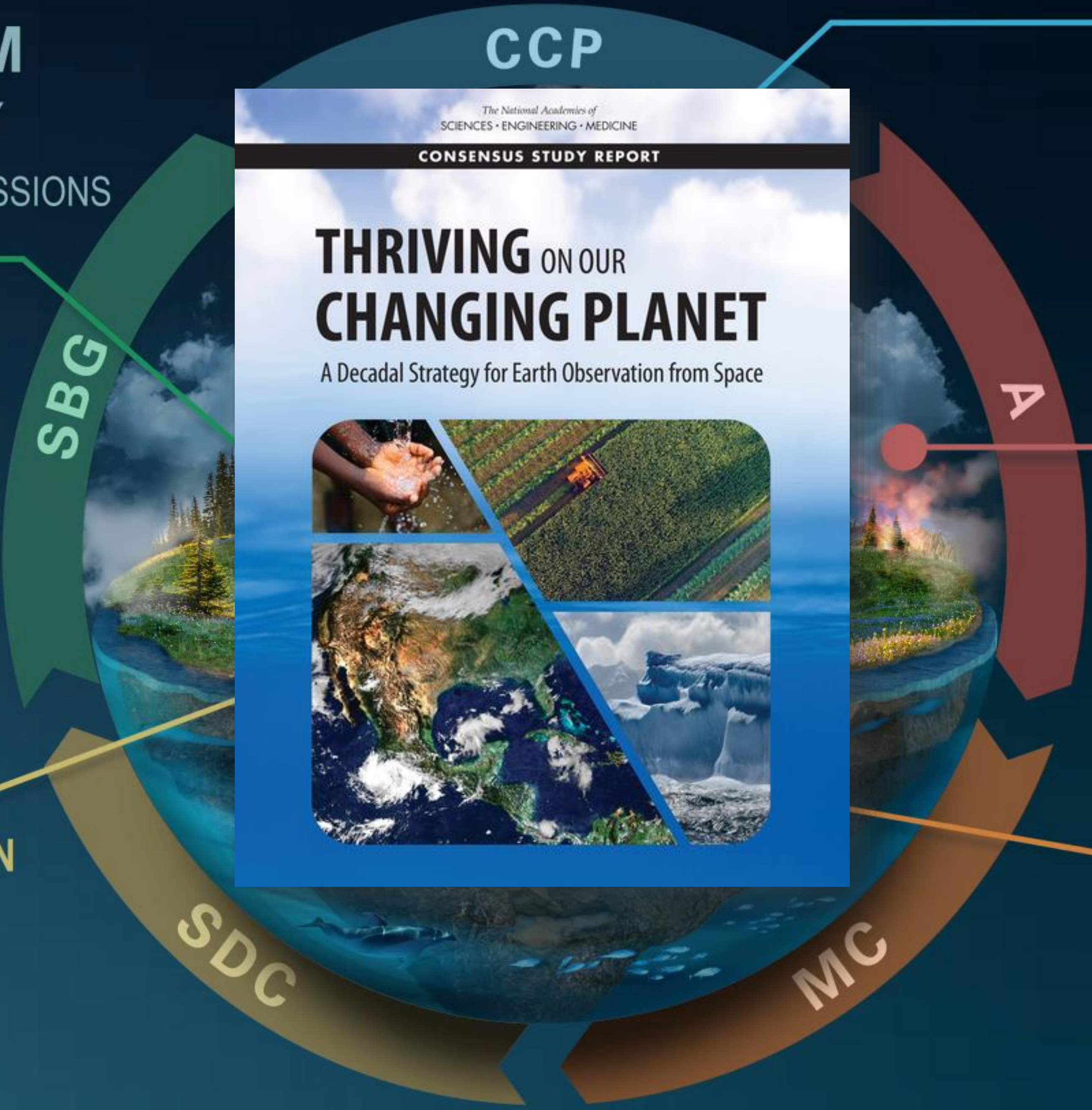
INTERCONNECTED CORE MISSIONS



CLOUDS, CONVECTION AND PRECIPITATION

Water and Energy in the Atmosphere

SURFACE BIOLOGY AND GEOLOGY

Earth Surface and Ecosystems

AEROSOLS

Particles in the Atmosphere

SURFACE DEFORMATION AND CHANGE

Earth Surface Dynamics

MASS CHANGE

Large-scale Mass Redistribution

Surface Deformation and Change – SDC Mission Architecture Study

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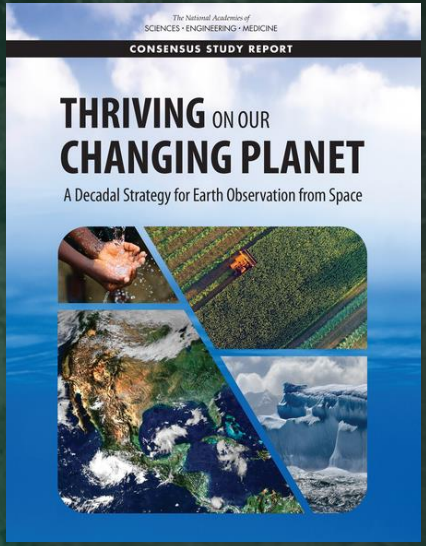
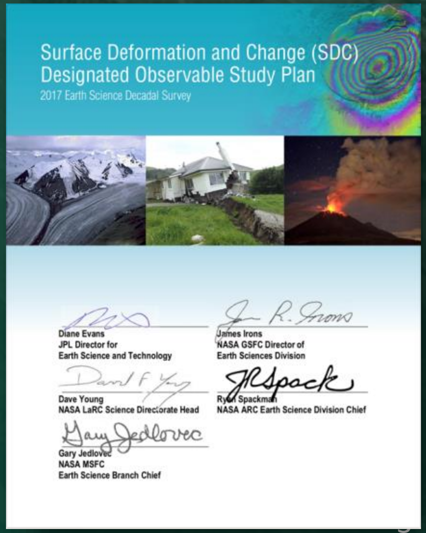
ESO will being with NISAR as a “trailblazer” for the ESO with SDC to follow.

SDC will consider the entire “program of record”, which includes data beyond its own system, but any SAR data that that is likewise free and openly available to the public. Such examples include:

- International SAR Constellations
- Commercial Data Purchased for Public Release

It is anticipated that partnerships will be needed to fully realize the vision described in the Decadal Survey.





Surface Deformation and Change

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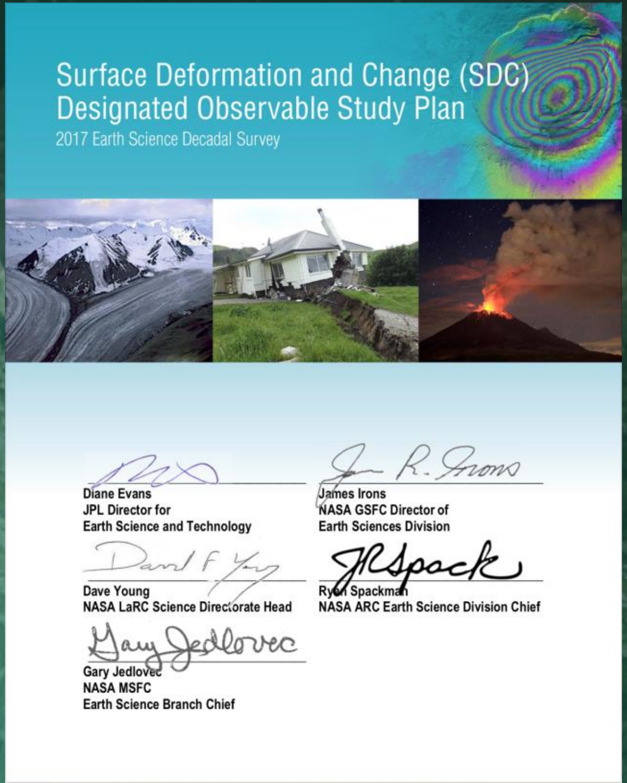
Architecture Study Objectives

Determine cost-effective SAR-based architecture to implement the Decadal Survey's Surface Deformation and Change Observable *SAR phase*

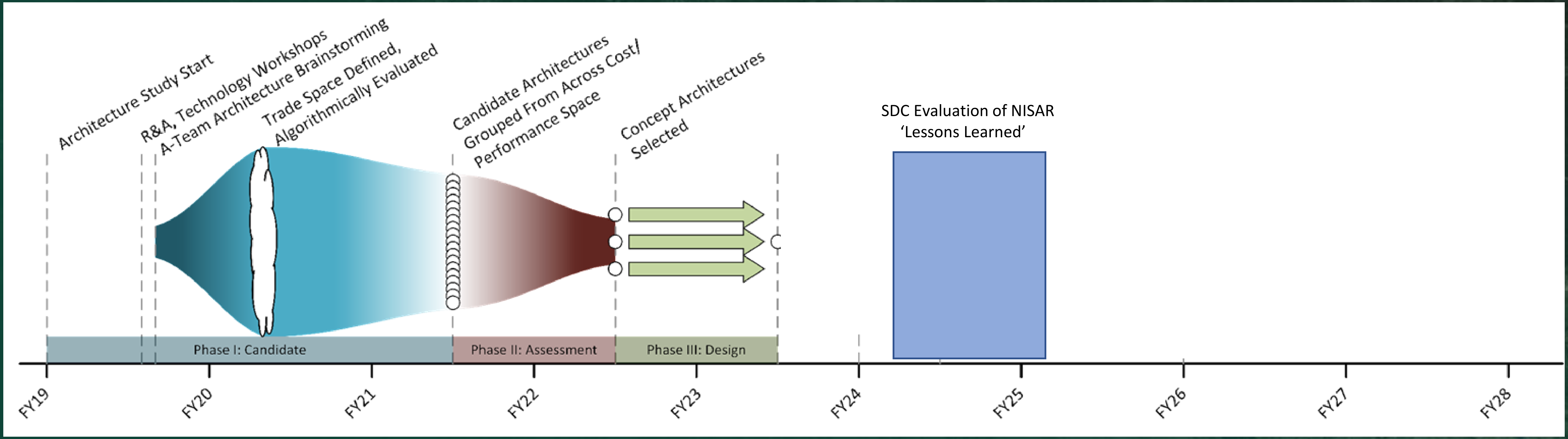
Evaluate other Science and Applications that SAR can enable in the trade space *SAR backscatter*

Engage emerging best and new practices in industry to maximize engagement and exploitation of commercial sector capabilities and interests, including smallsat constellations

Explore international partnerships to leverage capability and reduce cost.



Where are we today?



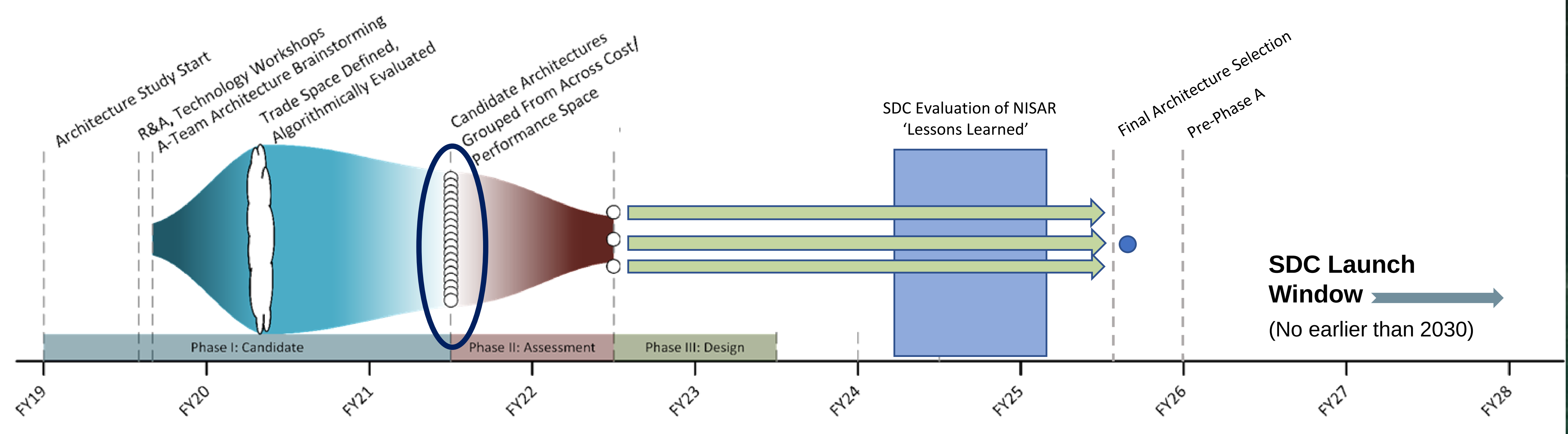
- Original SDC Study Timeline

- ESO: Lessons learned from NISAR will guide the SDC architecture development and selection

NISAR Launch

Commissioning + 3 yrs science ops

Where are we today?



- Original SDC Study Timeline

- ESO: Lessons learned from NISAR will guide the SDC architecture development and selection

- Final SDC selection will likely be mid-2025

NISAR Launch

Commissioning + 3 yrs science ops

- The SDC Study Team just completed the initial downselect

- **Today's Town Hall will review the SDC downselect approach and architectures that will be studied in detail**

Review of Architecture Creation

Architectures Identified by Capability

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Several classes of architectures under evaluation, each with a variety of implementations

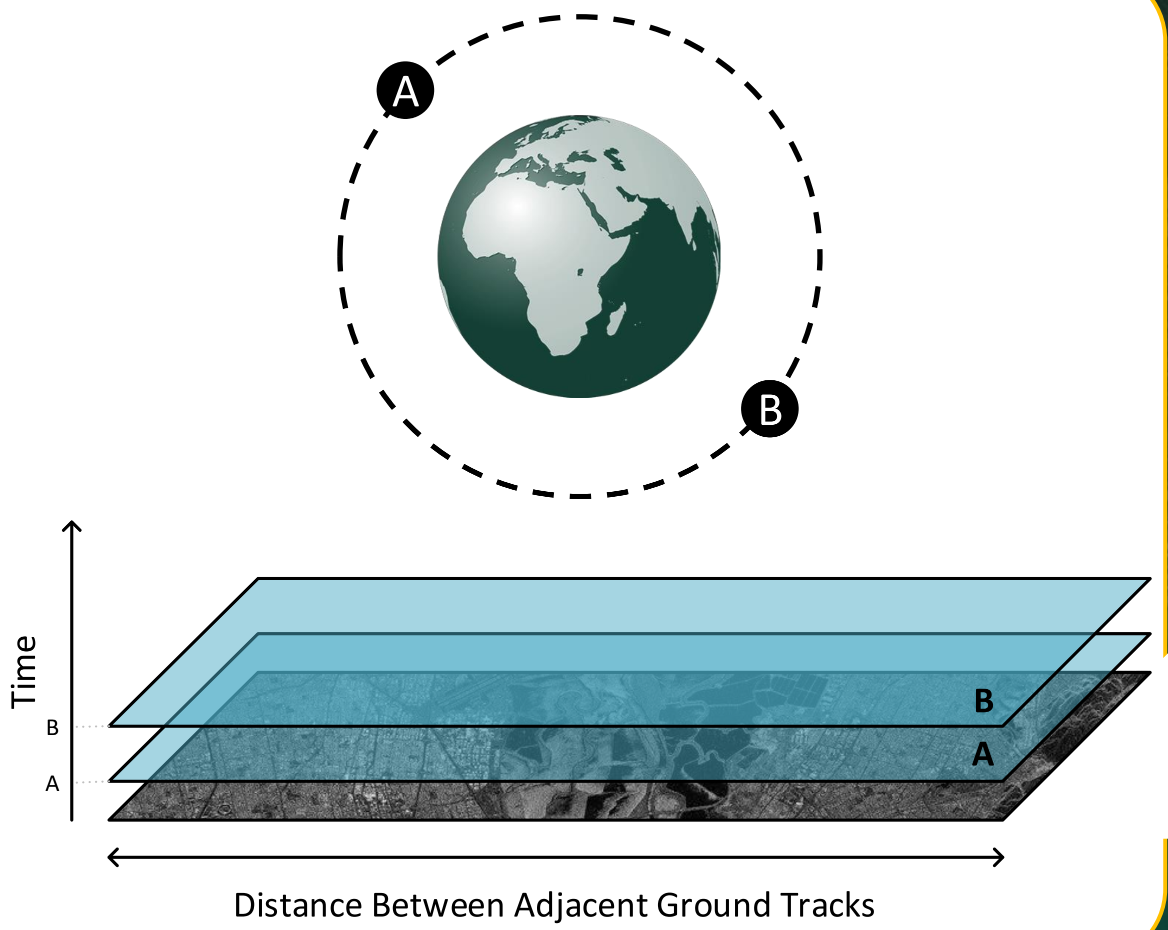
Each class offers advantages in different *capability* areas:

- **Continuity**: Likelihood of extending the current program of record beyond NISAR with overlap
- **Global Repeat Time**: Improving the time between interferometric repeat intervals globally
- **Local Repeat Time:** Improving the time between interferometric repeat intervals in targeted areas
- **Atmospheric Error Reduction**: Reducing measurement uncertainty via estimates of tropospheric delay
- **Look Diversity**: Improving deformation estimation in all 3 spatial dimensions to enable new science
- **STV Synergy:** Architectures providing synergy with the Surface Topography and Vegetation observable
- **Radiometry**: The ability to produce useful radiometric data in addition to interferometric products
- **Spatial Coverage**: The portion of the globe covered by the instrument in its repeat cycle

Flagship Fleet Architectures

- Characterized by individual spacecraft each with global coverage capability
- Adding spacecraft to the constellation increases the global temporal sampling rate
- Works well as a basis for multi-national collaboration or spec-based acquisition plan
- Requires firm commitment to the measurement because costs for a flagship architecture are high.
- ROSE-L is an example of this architecture paradigm.

Capability	Ranking
Continuity	
Global Repeat Time	
Local Repeat Time	
Atmospheric Error Reduction	
Look Diversity	
STV Synergy	



Distributed Repeat-Track Architectures

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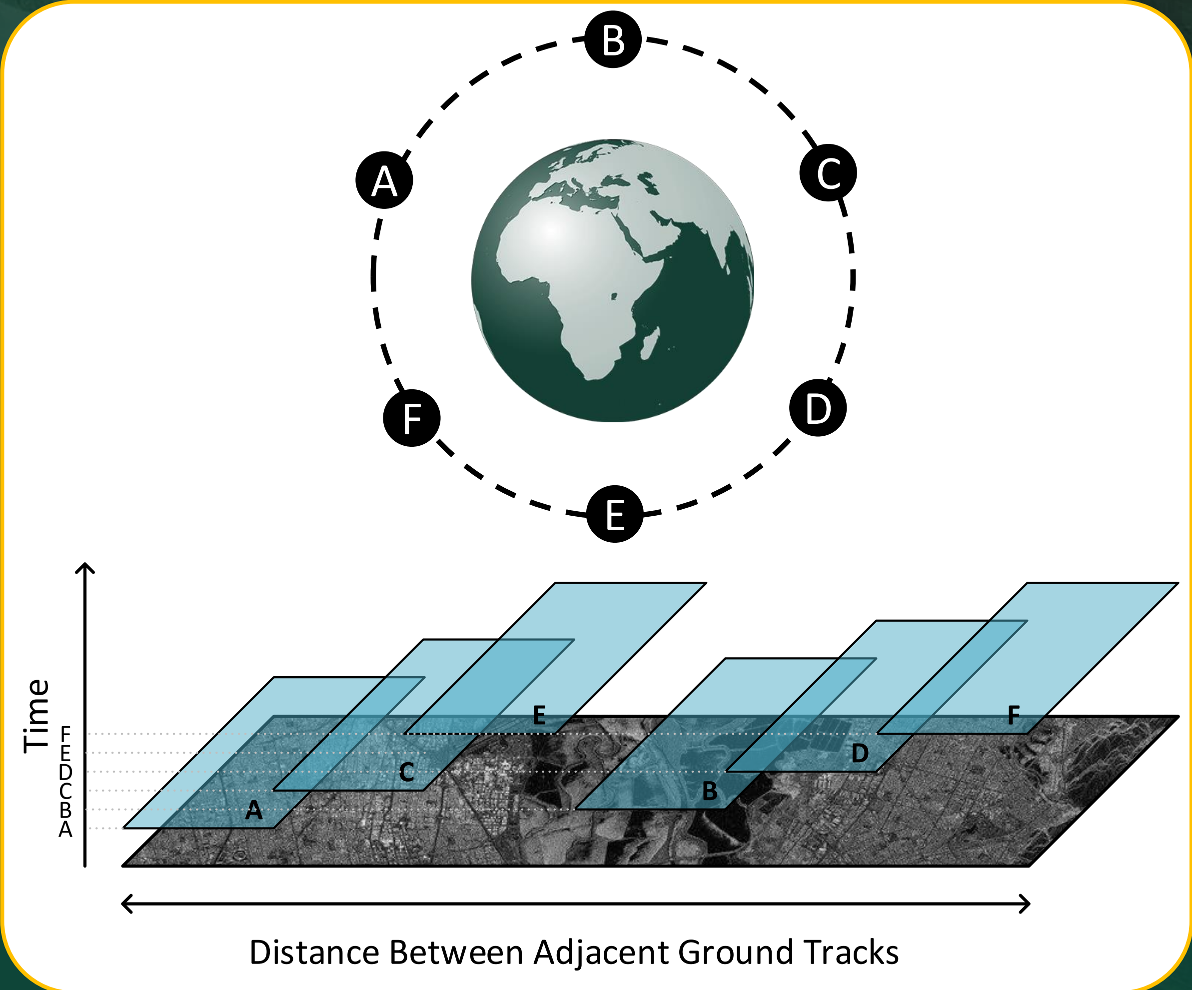
- N equally distributed smaller satellites that cover 1/N of the adjacent ground track swath
- Gets complete global coverage based on the orbital repeat period
- For urgent response needs, all satellites mechanically steered to the same look angle
- Decreases interferometric repeats by a factor of N over the desired sub-swath

Capability	Ranking
Continuity	
Global Repeat Time	
Local Repeat Time	
Atmospheric Error Reduction	
Look Diversity	
STV Synergy	



Multi-Squint Formation Architectures

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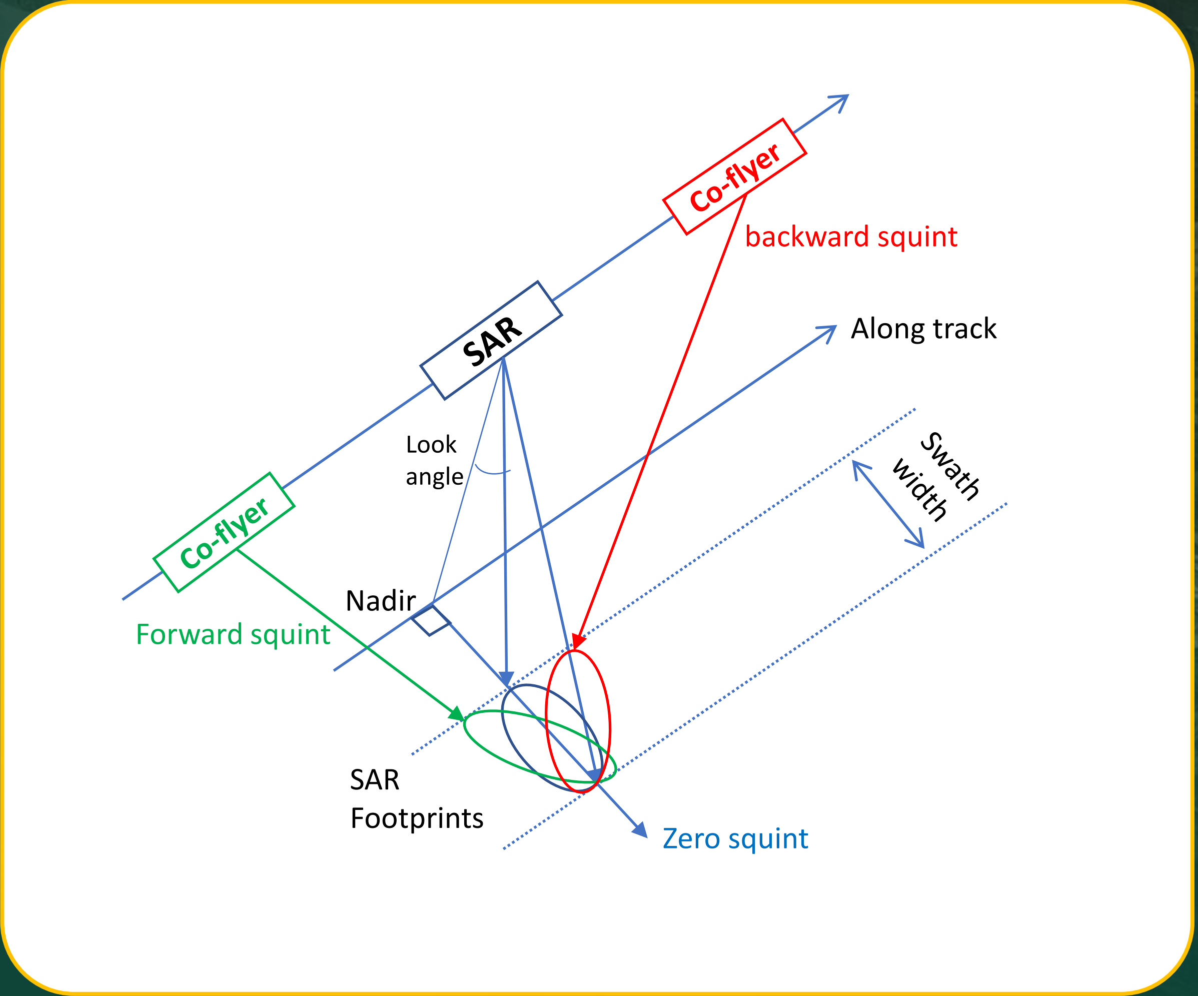
- Forward and backward squinted satellites, surrounding a zero-Doppler satellite
- Multiple real-time look angles enable accurate removal of tropospheric delay
- Look diversity enables good estimation of all 3 spatial components
- Enables new science at the expense of coverage density
- Concept presented by Mark Simons at Living Planet Symposium 2019

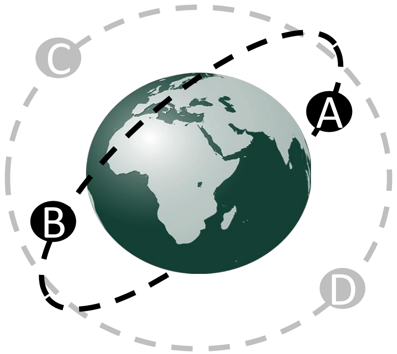
Capability	Ranking
Continuity	Green
Global Repeat Time	Yellow
Local Repeat Time	Yellow
Atmospheric Error Reduction	Green
Look Diversity	Green
STV Synergy	Red

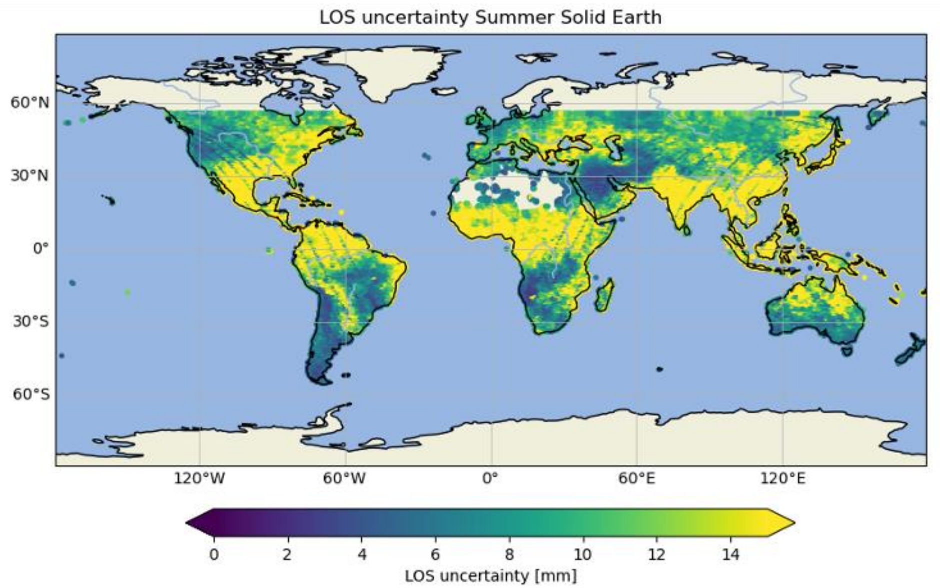


Lowered Inclination Architectures

- Lower the orbital inclination of the constellation to improve mid-latitude look diversity
- Would open larger holes over the poles
- Would provide faster non-interferometric revisit times
- Would likely need to be in conjunction with other open measurements in a sun-sync orbit
- First architecture shown that would depend on other instruments and programs to meet the full needs of SDC

Capability	Ranking
Continuity	
Global Repeat Time	
Local Repeat Time	
Atmospheric Error Reduction	
Look Diversity	
STV Synergy	

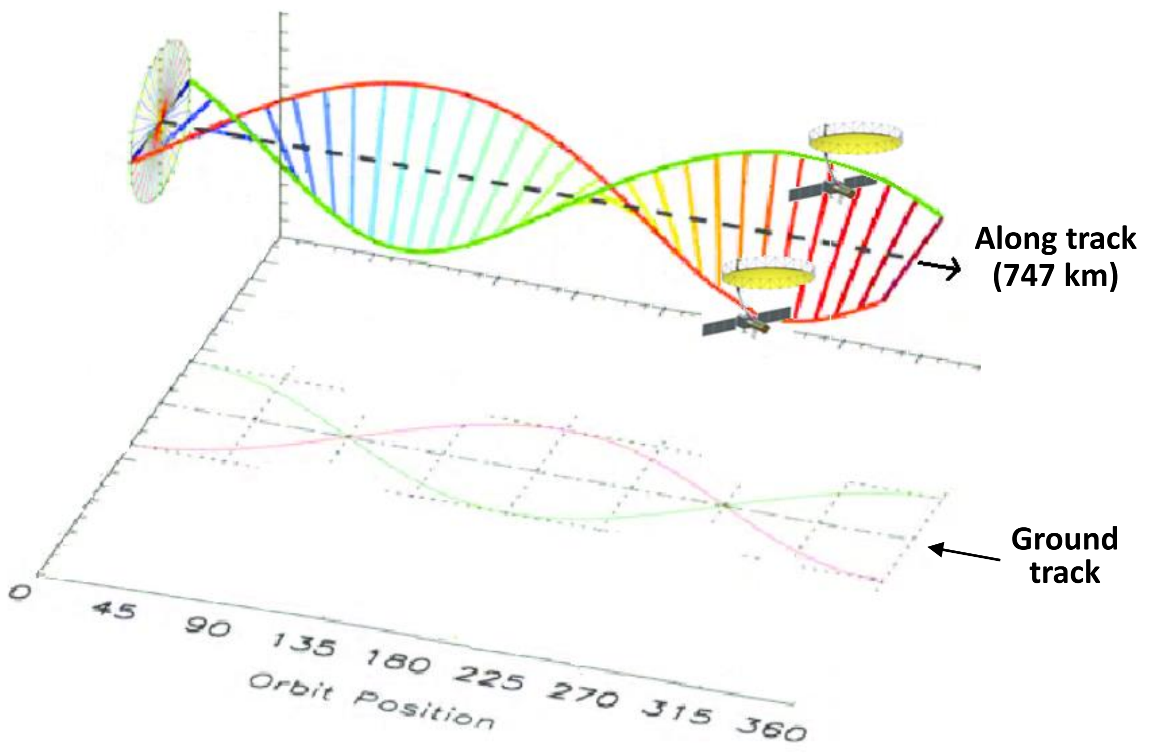




Helical Orbit Formation Architectures

- Operate multiple spacecraft in close proximity using a helical orbit (similar to TanDEM-X)
- Enables a variety of baselines for more than repeat-pass interferometry
- With enough spacecraft (>5), enables radar tomography for vegetation structure
- Modified zero-Doppler steering algorithms would lay down adjacent tracks for global coverage
- S/C diversity in this architecture does not lend itself as easily to atmospheric error correction or 3D deformation

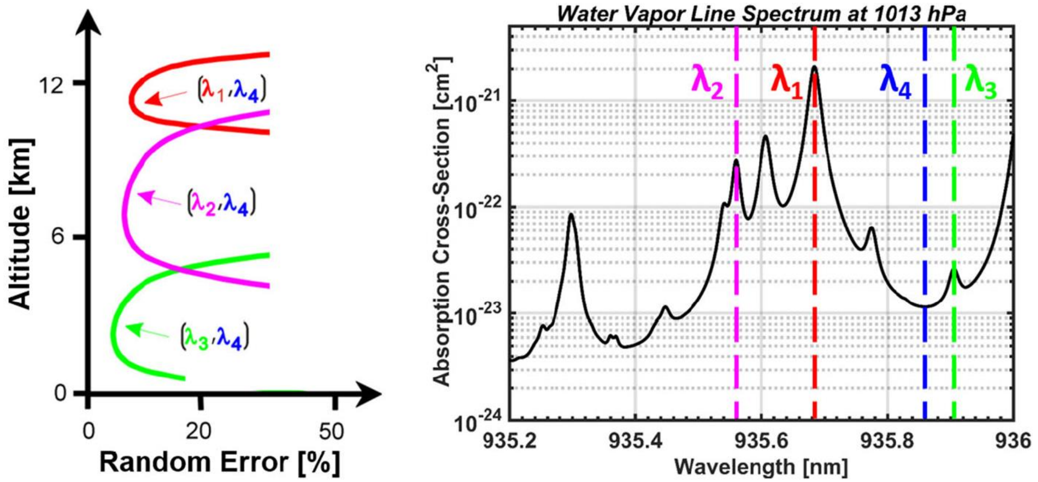
Capability	Ranking
Continuity	Red
Global Repeat Time	Yellow
Local Repeat Time	Yellow
Atmospheric Error Reduction	Yellow
Look Diversity	Yellow
STV Synergy	Green



Alternate Water Vapor Techniques

- Alternatives to multi-squint geometries for removing water vapor:
  - Differential Absorption Radar at millimeter wave frequencies
  - Scanning active phased array antennas squinting forward and back
- A passive microwave instrument flying in formation with another SAR instrument
- Provides tropospheric delay estimation without adding to the SAR coverage rate

Capability	Ranking
Continuity	
Global Repeat Time	
Local Repeat Time	
Atmospheric Error Reduction	
Look Diversity	
STV Synergy	



*A.R. Nehrir, et. al, "Emerging Technologies and Synergies for Airborne and Space-Based Measurements of Water Vapor Profiles", Surveys in Geophysics, 2017.

Down Selection Process Explanation

SDC Downselect Process (Phase II.a)

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Phase II.a Assessment
Science: Performance tool + heuristics
Applications: Feasibility + Mapping
Cost: High-level parametric/analogs
Risk: Initial mapping from survey
Programmatic Factors: Expert Opinion

Phase II.b Assessment
Science: Performance tool (+ heuristics), refined methodology
Applications: Refined methodology
Cost: Refined parametric/analogs, independent cost estimate
Risk: Risk matrix, technology readiness assessments
Programmatic Factors: Expert Opinion

Phase I

Potential Options (40)
- Large number of options with varying capabilities
- Identify key architecture elements/building blocks
- Identify drivers and trade-offs
- High-level metrics used to consolidate and refine architecture set
- Point of departure for deep dive assessments

Feasible Options (10)
- Smaller set of feasible architectures, warranting deeper dive
- Science, cost assessments are refined
- Risk, Programmatic factors are assessed
- Concurrent Eng. Studies

Recommended Options (~3)
Phase III

Final Arch.

June 2021
HQ Sync Point

June 2022
HQ Sync Point

Nov. 2022
HQ Sync Point

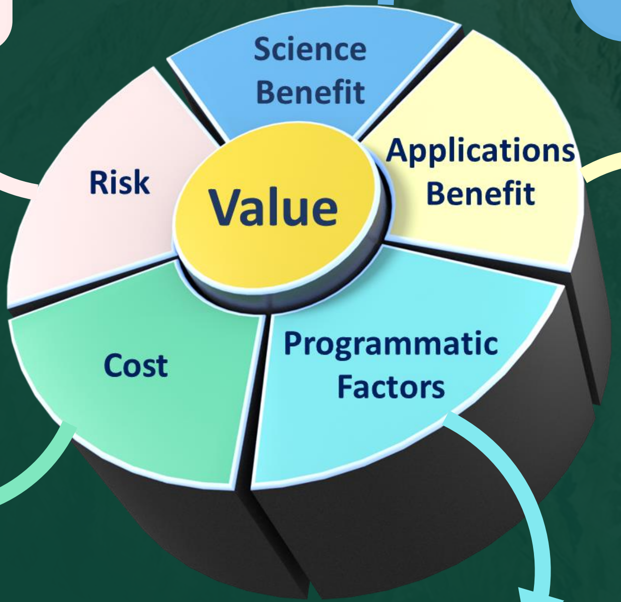
TBD FY23
HQ Sync Point

Phase III Assessment
Decision structuring: Identifying what is different relative to previous downselects
Assessment approach: Designing and implementing decision-making structure
Facilitation: Supporting assessments, analysis, and documentation of decision

Value in the SDC Study

- **Architecture Grouping (e.g. single flagship) risks**
- **Individual Architecture risks**

- **Feasibility** quantifies likelihood an architecture achieves Science performance targets for an Observable
- **Relevance** weights the utility of an Observable to a DS Goal
- **Benefit** is product of Feasibility and Relevance, aggregated at DS Goal level or higher



- **12 Communities and 26 Potential Enabled Applications mapped to Observables**

- **NASA Instrument Cost Mode**
- **Historical Analogues for Spacecraft**
- **NISAR-based operations estimates**

- **14 Programmatic Factors defined by study leadership with HQ**

Assessment Approach—Science Example

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SDC SATM derived from Decadal Survey

⇩

Architecture performance characterized by study team

⇩

Feasibility derived from architecture performance and SATM targets

⇩

Science Benefit incorporates Decadal Survey and SDC Community priorities

CLIMATE VARIABILITY AND CHANGE PANEL

SCIENCE			MEASUREMENT				
					Example Measurement Approach(s)		
Societal or Science Question	Earth Science/Application Objective	Sci/App Importance	Geophysical Observable	Measurement Parameters	*Method*	*POR*	*New*
QUESTION C-1. How much will sea level rise, globally and regionally, over the next decade and beyond, and what will be the role of ice sheets and ocean heat storage?	**C-1c.** Determine the changes in total ice sheet mass balance to within 15 Gton/yr over the course of a decade and the changes in surface mass balance and glacier ice discharge with the same accuracy over the entire ice sheets, continuously, for decades to come	**Most Important** DS example from the Cryosphere	Ice sheet mass	Horizontal resolution/range: 100 km / Global; Temporal sampling: Monthly; Precision: 1 cm water equivalent on scale of 200 km	Gravity (e.g., GRACE FO), NISAR/Landsat, [re-analysis], Operation IceBridge.	POR-30	
			Ice sheet velocity	Horizontal resolution/range: 100 m / pole to pole; Temporal sampling: weekly to daily; Precision: 1 m/yr in fast flow areas, 1 cm/yr near ice divides	SAR (e.g., NISAR), Landsat	POR-12	TO-19
			Ice sheet elevation	Vertical resolution/range: 10-20 cm; Horizontal resolution/range: 100 m/ pole to pole; Temporal sampling: weekly to daily; Precision: 10-20 cm	Operation IceBridge, ICESat-2, {WorldView satellites}, GLISTIN	POR-14	TO-20
			Ice sheet thickness, ice shelf thickness	Vertical resolution/range: 10 m pole to pole; Horizontal resolution/range: 100 m/ pole to pole; Temporal sampling: yearly; Precision: 10 m	Operation IceBridge, ICESat-2 (ice shelf), {WorldView satellites}	POR-14	TO-20
			Ice sheet bed elevation, ice shelf cavity shape	Vertical resolution/range: 30 m; Horizontal resolution/range: 100 m/ pole to pole; Temporal sampling: one time; Precision: 30 m	Operation IceBridge, EVS-2 OMG, new EVS Antarctica		TO-20
			Ice sheet surface mass balance	Vertical resolution/range: 1 mm/yr; Horizontal resolution/range: 5 km/ pole to pole; Temporal sampling: monthly; Precision: 1 mm/yr	Gravity (e.g., GRACE FO), ICESat-2, Operation IceBridge, [re-analysis data]	POR-14, 30	TO-20

- At HQ request, expanded scope of science beyond Decadal Survey, including addition of Ecosystems Focus Area
- Leveraged Focus Groups to define and refine SDC SATM

Societal or Science Question / Goal	Earth Science / Application Objective	Sci/App Importance	Geophysical Observable Most Important | Very Important | Important		Measurement Parameters Latency = 3 months for all observables
QUESTION C-1. How much will sea level rise, globally and regionally, over the next decade and beyond, and what will be the role of ice sheets and ocean heat storage?	C-1c. Determine the changes in total ice sheet mass balance to within 15 Gton/yr over the course of a decade and the changes in surface mass balance and glacier ice discharge with the same accuracy over the entire ice sheets, continuously, for	Most Important	Ice sheet velocity	Fast flowing outlet glaciers, grounded and floating (>50 m/yr)	Daily (targeted) to weekly (all), 1-5 m/yr horizontal precision, 100 m horizontal resolution
				Slow flowing ice-sheet interiors (<50 m/yr)	Once yearly, 0.1 m/yr horizontal accuracy, 1 km horizontal resolution
				Large mountain glaciers	Biweekly, 1-5 m/yr horizontal precision, 50 m horizontal resolution
			Shear margins strain rates		Daily to weekly, 1-5 m/yr horizontal precision, 10-25 m horizontal resolution
			Fracture and calving strain rates		Daily to weekly, 1-5 m/yr horizontal precision, 10-25 m horizontal resolution

Assessment Approach—Science Example

EARTH SYSTEM OBSERVATORY

SDC SATM derived from Decadal Survey

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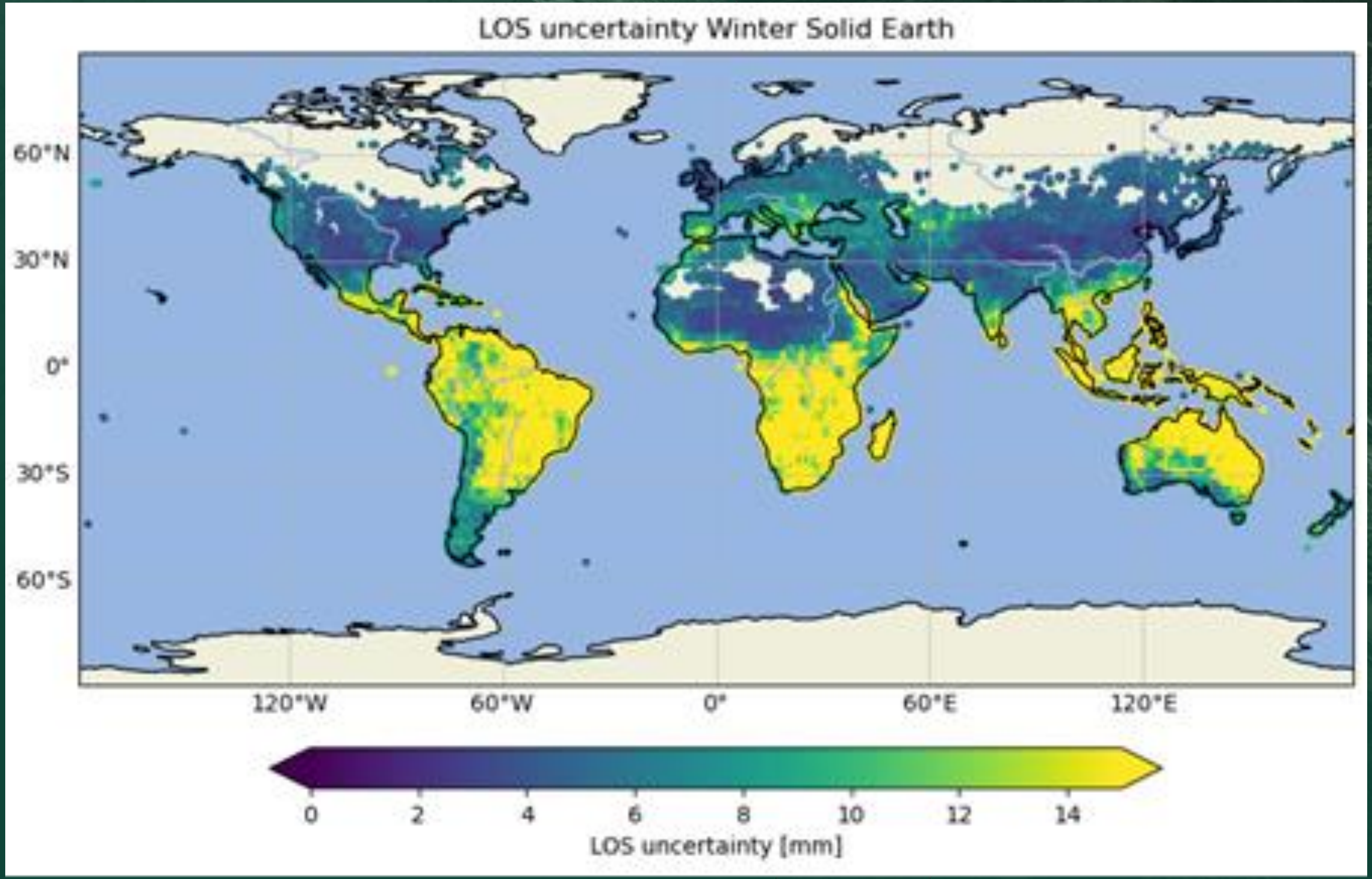
Architecture performance characterized by study team

⇩

Feasibility derived from architecture performance and SATM targets

⇩

Science Benefit incorporates Decadal Survey and SDC Community priorities



Assessment Approach—Science Example

EARTH SYSTEM OBSERVATORY

SDC SATM derived from Decadal Survey

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Architecture performance characterized by study team

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Feasibility derived from architecture performance and SATM targets

⇩

Science Benefit incorporates Decadal Survey and SDC Community priorities

	Revisit Time	Accuracy	Coverage	Spatial Resolution	
SATM Targets	6	100	0.7	200	
Architecture A	12	200	0.7	75	
Architecture B	12	400	0.7	75	
Component of Feasibility for A	0.125	0.125	0.25	0.25	Σ
Component of Feasibility for B	0.125	0.0625	0.25	0.25	Σ

Total Feasibility for A	0.75
Total Feasibility for B	0.6875

Assessment Approach—Science Example

EARTH SYSTEM OBSERVATORY

SDC SATM derived from Decadal Survey

⇩

Architecture performance characterized by study team

⇩

Feasibility derived from architecture performance and SATM targets

⇩

Science Benefit incorporates Decadal Survey and SDC Community priorities

$$B_i = F_i R_i \qquad R_i = \frac{N_i I_i}{\sum_{k=1}^{n_j} N_k I_k}$$

B_i	Benefit of Geophysical Observable *i*
F_i	Feasibility for Geophysical Observable *i*
R_i	Relevance of Geophysical Observable *i*
N_i	Necessity of Geophysical Observable *i*
I_i	Importance of Geophysical Observable *i*
n_j	Number of Geophysical Observables for Decadal Survey Goal *j*

Value Framework Products and Tools Structure
Traceable Assessments

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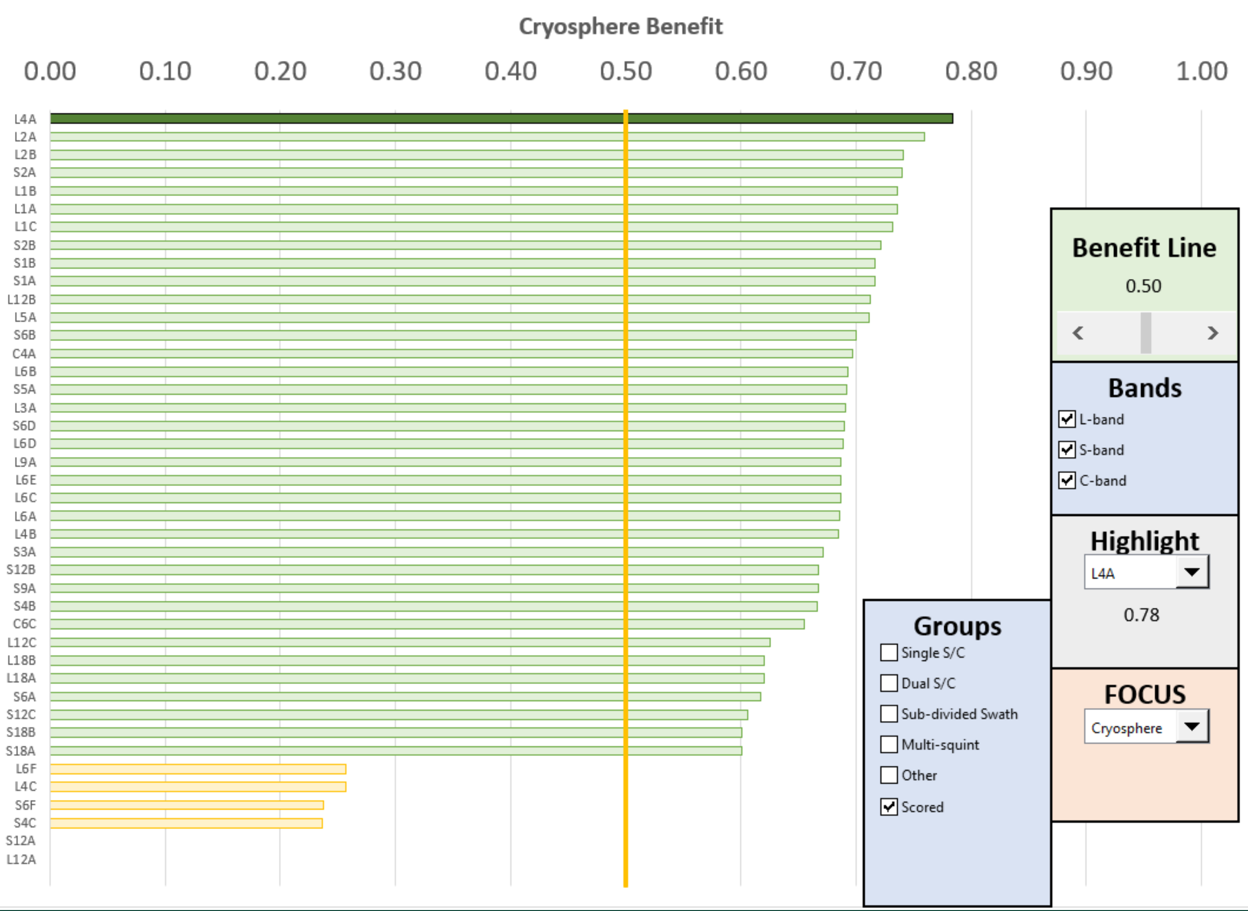
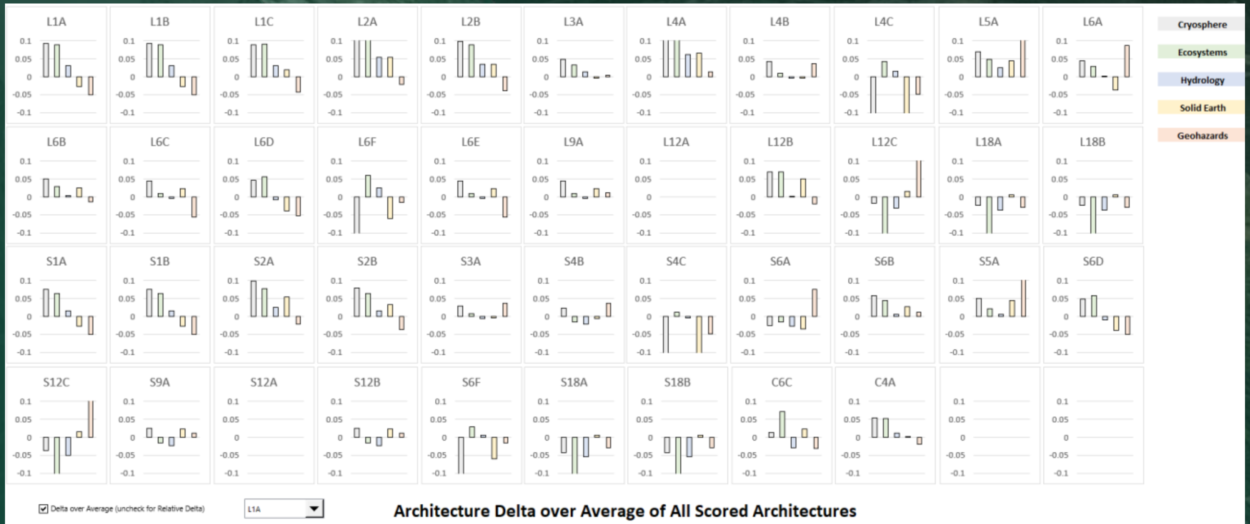
Comparison among all architectures by each dimension



Relative Science Benefit scores compared to averages



Focused comparisons of subsets of architectures

Programmatic Factor	L1A	S1A	L2A	S2A
Leveraging International Participation	1	2	1	2
Supporting US Agencies	3	3	3	3
Leveraging US Agencies	1	1	3	3
Commercial Data Buy Science Leveraging Opportunities	1	1	1	1
Other POR/ESO/ESTO Missions/Developments Benefits to SDC	5	4	5	4
Architectural / Technology Innovation	1	3	1	1
Enhance science return capability	1	1	2	2
Programmatic on-ramps/off-ramps (Architecture design flexibility/agility)	1	1	3	3
Funding Profile Flexibility	3	2	1	1
Science Return Flexibility	3	3	3	3
Programmatic redundancy as risk mitgation for on-orbit failures	1	1	2	2
Schedule Flexibility	3	3	1	1
Continuity	5	3	5	5
Programmatic Risk (not techincal or cost risk)	5	1	4	4

Initial Architecture Down-selection Results

Contributors:
Ala Khazendar (JPL)
*Batu Osmanoglu (GFSC)
Christopher Jones (LaRC)
Katia Tymofyeyeva (JPL)
Shadi Oveisgharan (JPL)
Stephen Horst (JPL)

Selected Architectures

Architecture	Characteristic	Orbital Phasing Groups	Pol.	Repeat Period (Days)	Per Satellite Swath (km)	Relative Cost
L1C	NISAR w/PWV inst.	1	Quad	12	240.0	2.9
L4A	2x NISAR w/Rose-L	4	Quad	3	240.0	3.6
L5A	NISAR via 5 Small Sats.	5	Dual	2/8	60.0	1.6
L6C	Rose-L Active Multi-Squint Co-fliers	2	Single	6	80.0*	1.0
L6E	Rose-L Passive Multi-Squint Co-fliers	2	Dual	6	80.0*	2.0
L8A	Sub-Daily Repeat	1	Dual	0.25/12	30.0	2.1
L9A	NISAR via Multi-Squint Co-fliers	3	Dual	4/12	80.0	2.4
L12B	Multi-Baseline Helical Orbit	2	Dual	6	40.0	2.3
L12C	Fast Revisit Low Cost per Sat.	12	Single	1/4	60.0	1.8
L18A	Multi-Squint Low Cost per Sat.	6	Single	2/8	60.0	2.2

*Reported swath is for the co-fliers, not Rose-L.

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Revisit Time vs. Number of Satellites

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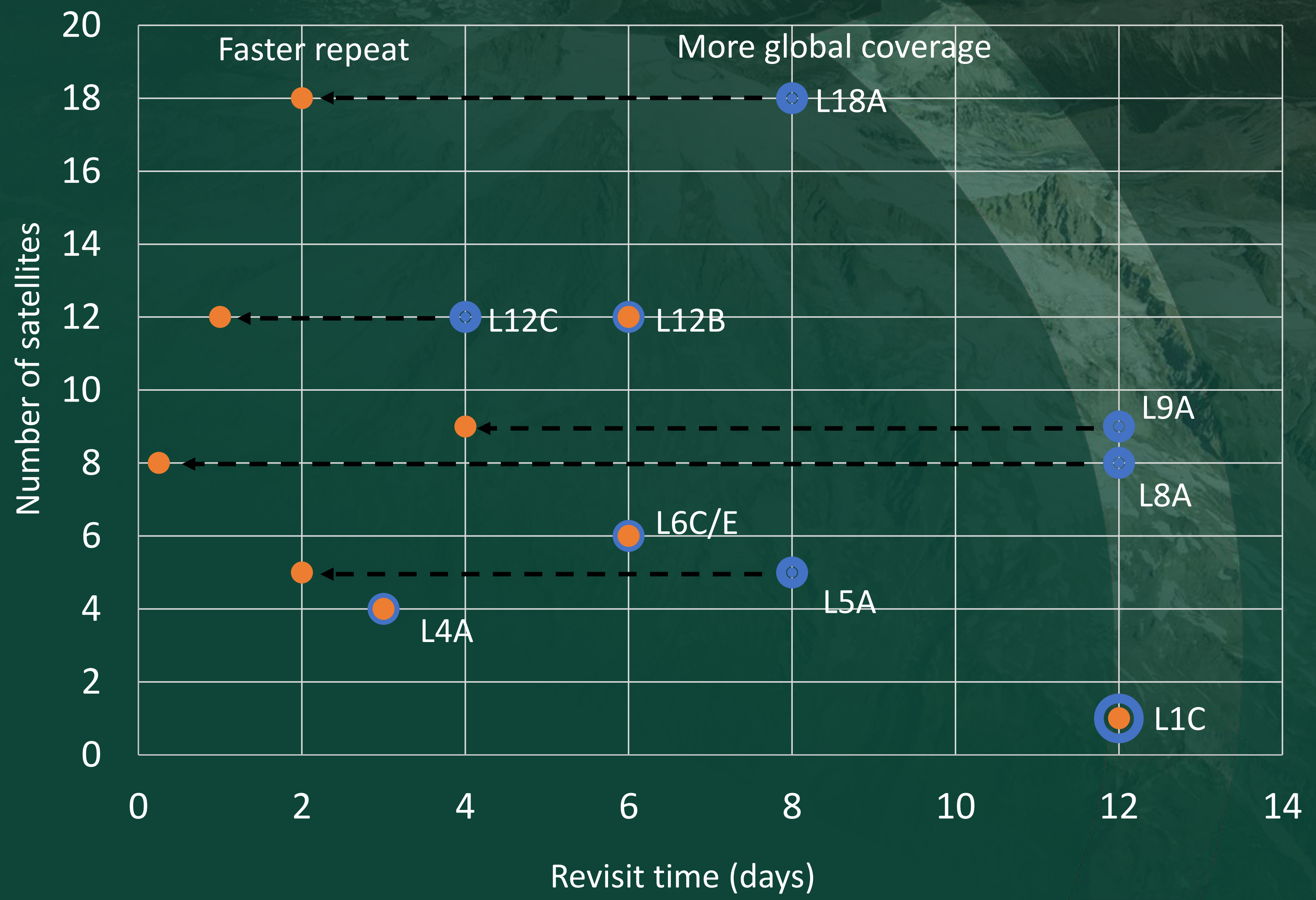
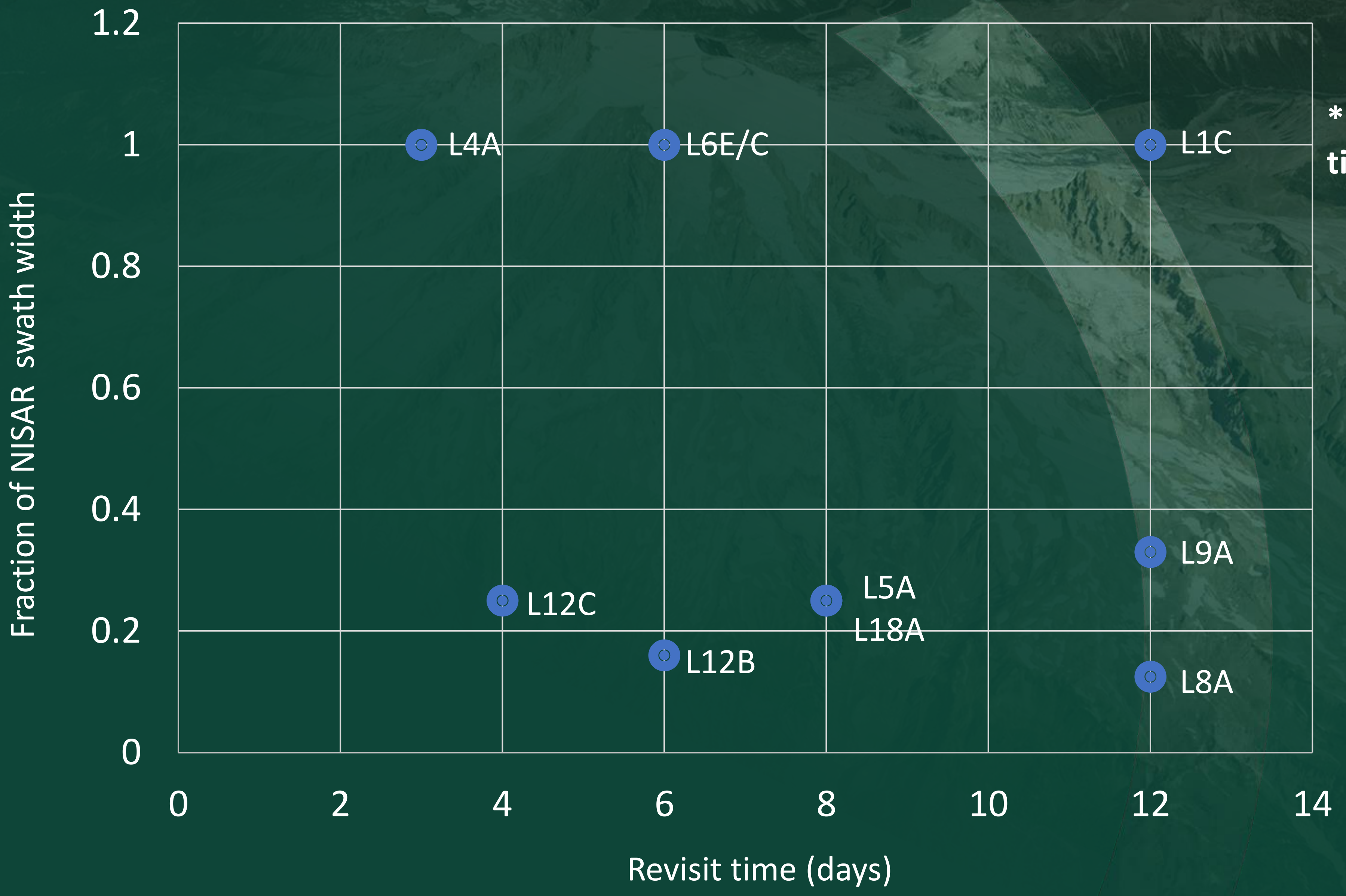


Revisit Time vs. Swath Width



*Maximum repeat time used here.

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Look Diversity vs. Coverage

Look Diversity FOM = 2*Number of S/C in formation* 0.75 if lowered inclination

Top overall. Geohazards is average to poor. Flagships. Quad pol.	L4A	Top performer in Cryosphere, Solid Earth, Ecosystems and Hydrology. Average in Geohazards.
	L2A S2A	Top performer in Cryosphere, Solid Earth, Ecosystems and Hydrology. Below average in Geohazards.
Top in Hydrology / Ecosystems; good in Cryosphere; poor in Geohazards. NISAR-Lite; same temporal sampling. Quad pol.	L2B S2B L1B S1B	Missions are expected to achieve similar accuracies. L2B has above average performances in Solid Earth; L1B is below average.
	L1C L1A S1A	The high accuracy requirements of Solid Earth and Geohazards can be better met by L1C than L1A/S1A given its atmospheric instrument (PWV).
Top in Geohazards. Fast revisit, low cost/satellite.	L12C S12C	Low SB scores in Ecosystems, Cryosphere and Solid Earth are mostly due to these constellations using low radiometric accuracy and low orbital duty cycle to lower the cost. Low duty cycle does not imply gaps in coverage, but less observations of points on the surface which would reduce accuracy.
	L6A S6A	Disaster observation can be 6x NISAR. Top performers in Geohazards. Poor in Solid Earth. Average in the other FAs.
	L5A S5A	Disaster observation can be 6x NISAR. Does relatively well in Geohazards, and average in the other FAs.
Average across FAs, with exceptions. NISAR via multi-squint co-fliers.	L6B S6B	Disaster observation can be 2x NISAR. Above average in Cryosphere.
	L9A S9A	Disaster observation can be 3x NISAR. Dual pol. Average across all FAs.
	L6C L6E	Targets both 3D deformation and atmospheric removal. Disaster observation can be 2x NISAR. Above average in Cryosphere. Poor in Geohazards. Average in the other FAs.
	C6C	Above average in Ecosystems. Poor in Geohazards.
Average across FAs, with exceptions.	C4A	3x NISAR's temporal sampling.
	L12B S12B S6D L6D	Alternate modes would perform STV and cross-along-track interferometry objectives. L12B: Good in Solid Earth. Above average in Ecosystems and Cryosphere.
	L4B S4B	Mechanical steering can provide 4x NISAR's disaster sampling. Above average in Geohazards.
	L3A S3A	Disaster observation can be 3x NISAR. S3A: Above average in Geohazards.
Poor in Cryosphere, Solid Earth and Geohazard. Above average in Hydrology and Ecosystems. Lowered inclination orbits. Dual pol.	L4C S4C L6F S6F	Low SB scores, particularly in Cryosphere and Solid Earth, are mostly due to the lowered inclination orbit. Cryosphere needs to be covered through X-band commercial data purchases, if feasible. L6F and L4C: Good to above average in Hydrology and Ecosystems.
Below average to poor across all FAs. Multi-squint, low radiometric accuracy, and duty cycle. Single pol. Low cost/satellite	L18A S18A L18B S18B	Low SB scores in Ecosystems, Cryosphere and Solid Earth are mostly due to these constellations using low radiometric accuracy and low orbital duty cycle to lower the cost. Poor performance in Ecosystems is also due to single pol.

Selected   Frequency Study   Architecture Not Down-selected

Architecture Science Benefit scores per Focus Area

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Arch.	Cryo.	Eco.	Hydro.	Solid Earth	Geo Haz.
L1A	0.74	0.82	0.57	0.70	0.56
L1B	0.74	0.82	0.57	0.70	0.56
L1C	0.73	0.82	0.57	0.75	0.57
L2A	0.76	0.84	0.59	0.79	0.59
L2B	0.74	0.82	0.57	0.77	0.57
L3A	0.69	0.76	0.55	0.73	0.62
L4A	0.78	0.85	0.60	0.80	0.63
L4B	0.69	0.74	0.54	0.73	0.65
L4C	0.26	0.77	0.56	0.61	0.56
L5A	0.71	0.78	0.57	0.78	0.72
L6A	0.69	0.76	0.54	0.69	0.70
L6B	0.69	0.76	0.55	0.76	0.60
L6C	0.69	0.74	0.54	0.76	0.56
L6D	0.69	0.79	0.53	0.69	0.56
L6F	0.26	0.79	0.57	0.67	0.60
L6E	0.69	0.74	0.54	0.76	0.56
L9A	0.69	0.74	0.54	0.76	0.62
L12B	0.71	0.80	0.54	0.78	0.59
L12C	0.63	0.50	0.51	0.75	0.79
L18A	0.62	0.50	0.50	0.74	0.58
L18B	0.62	0.50	0.50	0.74	0.58

Arch.	Cryo.	Eco.	Hydro.	Solid Earth	Geo Haz.
S1A	0.72	0.79	0.56	0.70	0.56
S1B	0.72	0.79	0.56	0.70	0.56
S2A	0.74	0.81	0.57	0.78	0.59
S2B	0.72	0.79	0.56	0.77	0.58
S3A	0.67	0.74	0.54	0.73	0.65
S4B	0.67	0.72	0.52	0.73	0.65
S4C	0.24	0.74	0.54	0.61	0.56
S6A	0.62	0.72	0.51	0.70	0.69
S6B	0.70	0.78	0.55	0.76	0.62
S5A	0.69	0.75	0.55	0.78	0.72
S6D	0.69	0.79	0.53	0.69	0.56
S9A	0.67	0.72	0.52	0.75	0.62
S12B	0.67	0.72	0.52	0.75	0.62
S6F	0.24	0.76	0.55	0.67	0.60
S12C	0.61	0.47	0.49	0.75	0.79
S18A	0.60	0.47	0.49	0.74	0.58
S18B	0.60	0.47	0.49	0.74	0.58
C6C	0.66	0.80	0.51	0.75	0.58
C4A	0.70	0.78	0.55	0.73	0.59

Architecture Science Benefit scores per Focus Area

EARTH SYSTEM OBSERVATORY

Arch.	Cryo.	Eco.	Hydro.	Solid Earth	Geo Haz.
L1A	0.74	0.82	0.57	0.70	0.56
L1B	0.74	0.82	0.57	0.70	0.56
L1C	0.73	0.82	0.57	0.75	0.57
L2A	0.76	0.84	0.59	0.79	0.59
L2B	0.74	0.82	0.57	0.77	0.57
L3A	0.69	0.76	0.55	0.73	0.62
L4A	0.78	0.85	0.60	0.80	0.63
L4B	0.69	0.74	0.54	0.73	0.65
L4C	0.26	0.77	0.56	0.61	0.56
L5A	0.71	0.78	0.57	0.78	0.72
L6A	0.69	0.76	0.54	0.69	0.70
L6B	0.69	0.76	0.55	0.76	0.60
L6C	0.69	0.74	0.54	0.76	0.56
L6D	0.69	0.79	0.53	0.69	0.56
L6F	0.26	0.79	0.57	0.67	0.60
L6E	0.69	0.74	0.54	0.76	0.56
L9A	0.69	0.74	0.54	0.76	0.62
L12B	0.71	0.80	0.54	0.78	0.59
L12C	0.63	0.50	0.51	0.75	0.79
L18A	0.62	0.50	0.50	0.74	0.58
L18B	0.62	0.50	0.50	0.74	0.58

Arch.	Cryo.	Eco.	Hydro.	Solid Earth	Geo Haz.
S1A	0.72	0.79	0.56	0.70	0.56
S1B	0.72	0.79	0.56	0.70	0.56
S2A	0.74	0.81	0.57	0.78	0.59
S2B	0.72	0.79	0.56	0.77	0.58
S3A	0.67	0.74	0.54	0.73	0.65
S4B	0.67	0.72	0.52	0.73	0.65
S4C	0.24	0.74	0.54	0.61	0.56
S6A	0.62	0.72	0.51	0.70	0.69
S6B	0.70	0.78	0.55	0.76	0.62
S5A	0.69	0.75	0.55	0.78	0.72
S6D	0.69	0.79	0.53	0.69	0.56
S9A	0.67	0.72	0.52	0.75	0.62
S12B	0.67	0.72	0.52	0.75	0.62
S6F	0.24	0.76	0.55	0.67	0.60
S12C	0.61	0.47	0.49	0.75	0.79
S18A	0.60	0.47	0.49	0.74	0.58
S18B	0.60	0.47	0.49	0.74	0.58
C6C	0.66	0.80	0.51	0.75	0.58
C4A	0.70	0.78	0.55	0.73	0.59

Selected Architectures - Deformation Science Perspective

EARTH SYSTEM OBSERVATORY

Architecture	Characteristic	Continuity	Improved accuracy	Rapid repeat sampling
L1C	*NISAR w/PWV inst.*			
L4A	*2x NISAR w/ROSE-L*			
L5A	*NISAR via 5 Small Sats.*			
L6C	*ROSE-L Active Multi-Squint Co-fliers*			
L6E	*ROSE-L Passive Multi-Squint Co-fliers*			
L8A	*Sub-Daily Repeat*			
L9A	*NISAR via Multi-Squint Co-fliers*			
L12B	*Multi-Baseline Helical Orbit*			
L12C	*Fast Revisit Low Cost per Sat.*			
L18A	*Multi-Squint Low Cost per Sat.*			

Level of Improvement

- Large
- Medium
- Small
- NISAR-like

Selected Architectures – Radiometric-based Science Perspective

EARTH SYSTEM OBSERVATORY

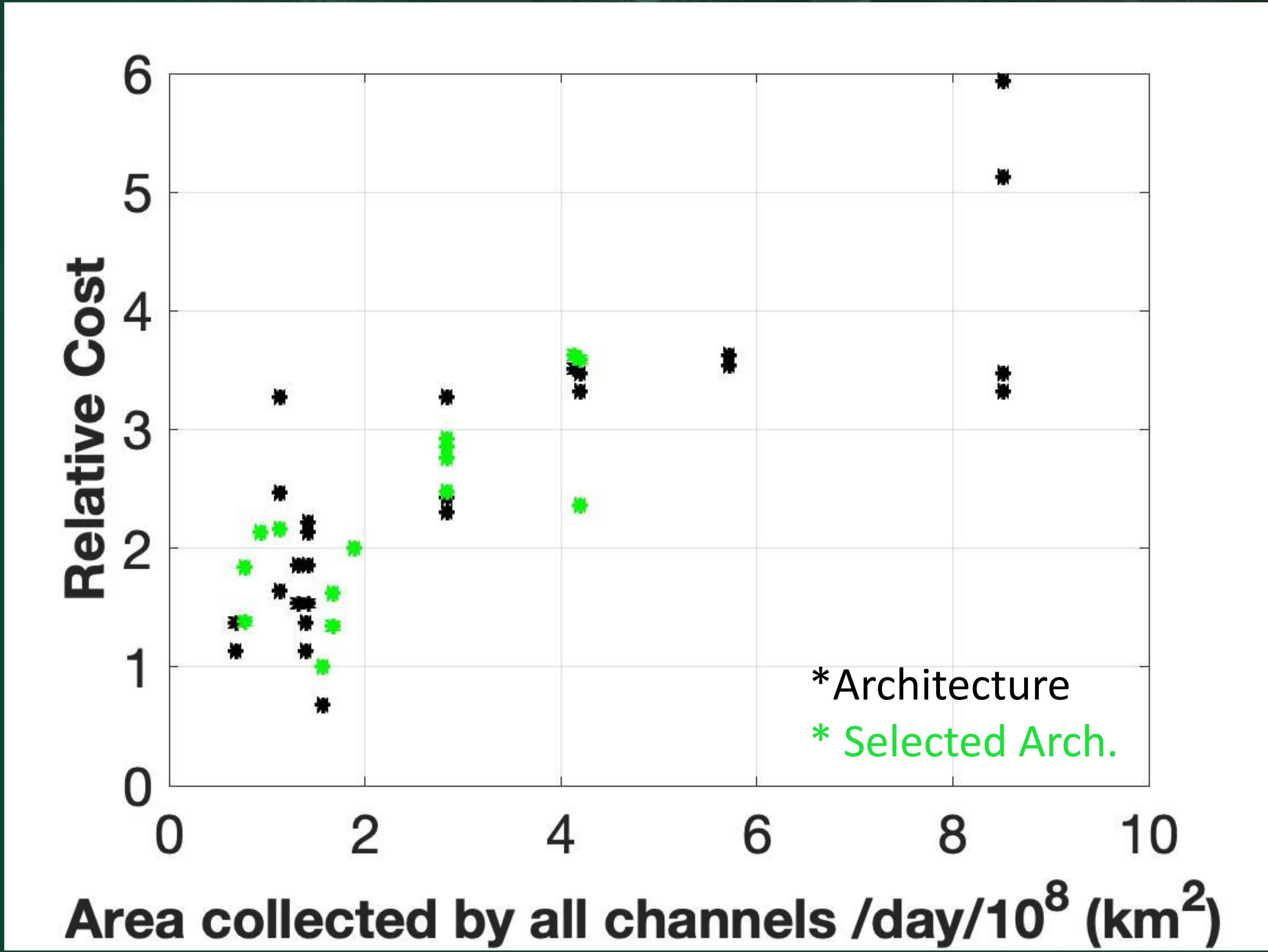
Architecture	Characteristic	Continuity	Improved accuracy	Rapid repeat sampling
L1C	*NISAR w/PWV inst.*			
L4A	*2x NISAR w/ROSE-L*			
L5A	*NISAR via 5 Small Sats.*			
L6C	*ROSE-L Active Multi-Squint Co-fliers*			
L6E	*ROSE-L Passive Multi-Squint Co-fliers*			
L8A	*Sub-Daily Repeat*			
L9A	*NISAR via Multi-Squint Co-fliers*			
L12B	*Multi-Baseline Helical Orbit*			
L12C	*Fast Revisit Low Cost per Sat.*			
L18A	*Multi-Squint Low Cost per Sat.*			

Level of Improvement

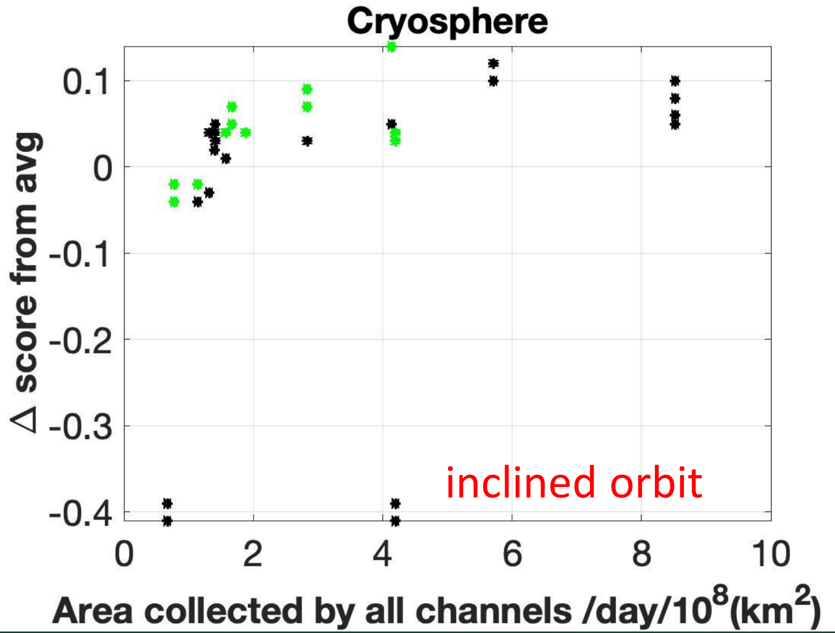
- Large
- Medium
- Small
- NISAR-like
- No Polarimetry

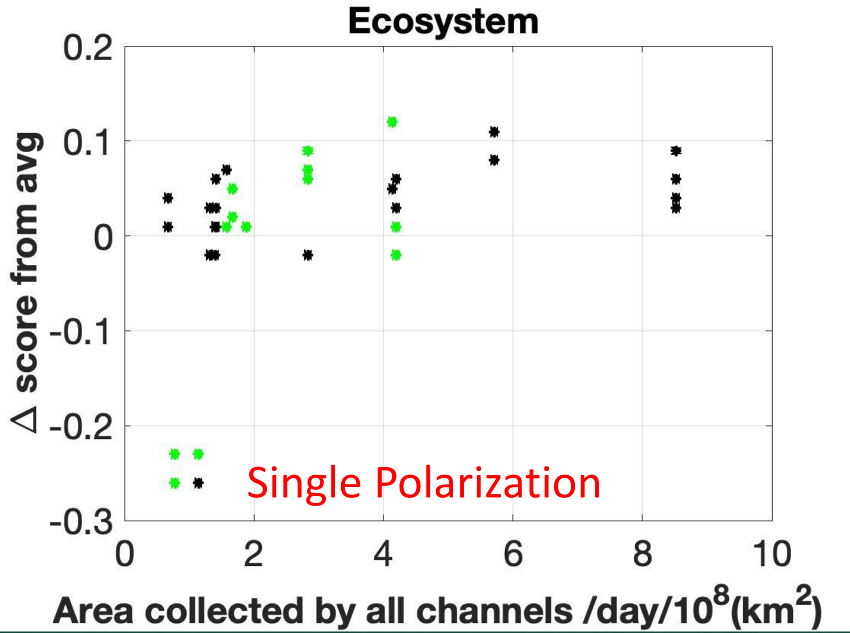
Relative cost vs. area collected

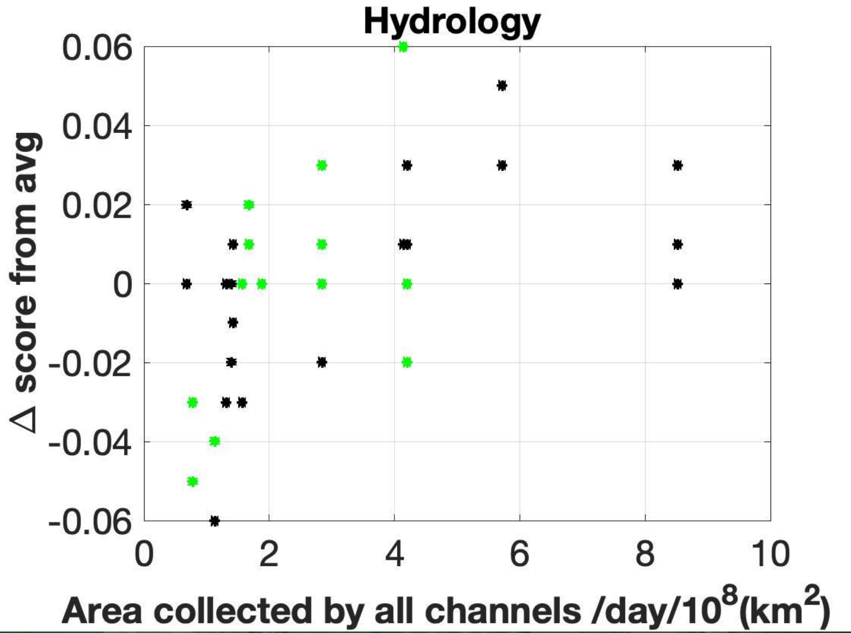
EARTH SYSTEM OBSERVATORY

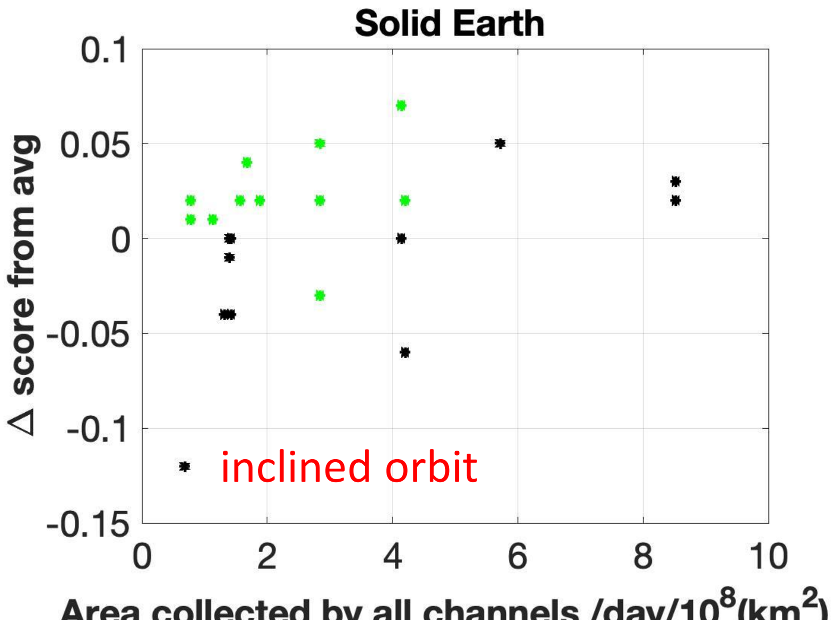


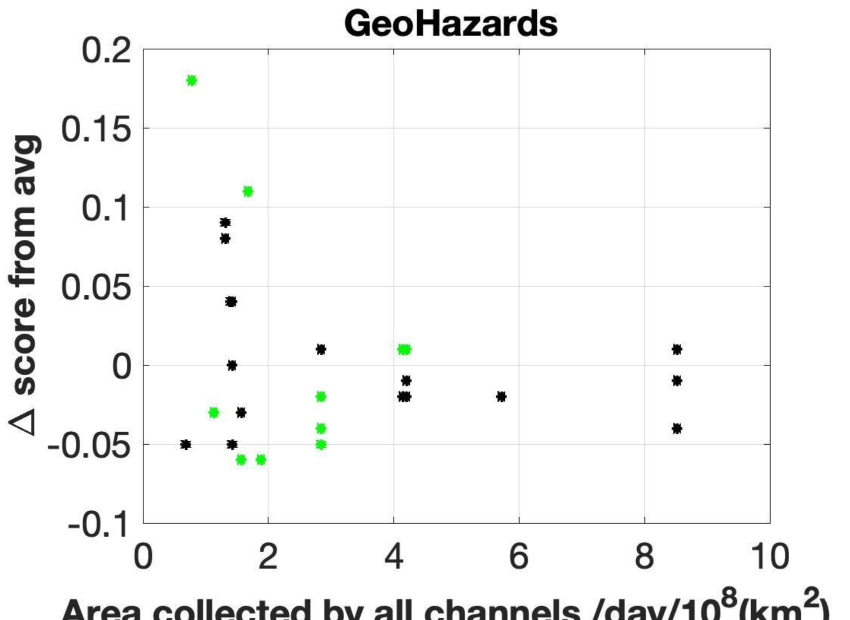
Focus area score vs. Area collected (coverage)



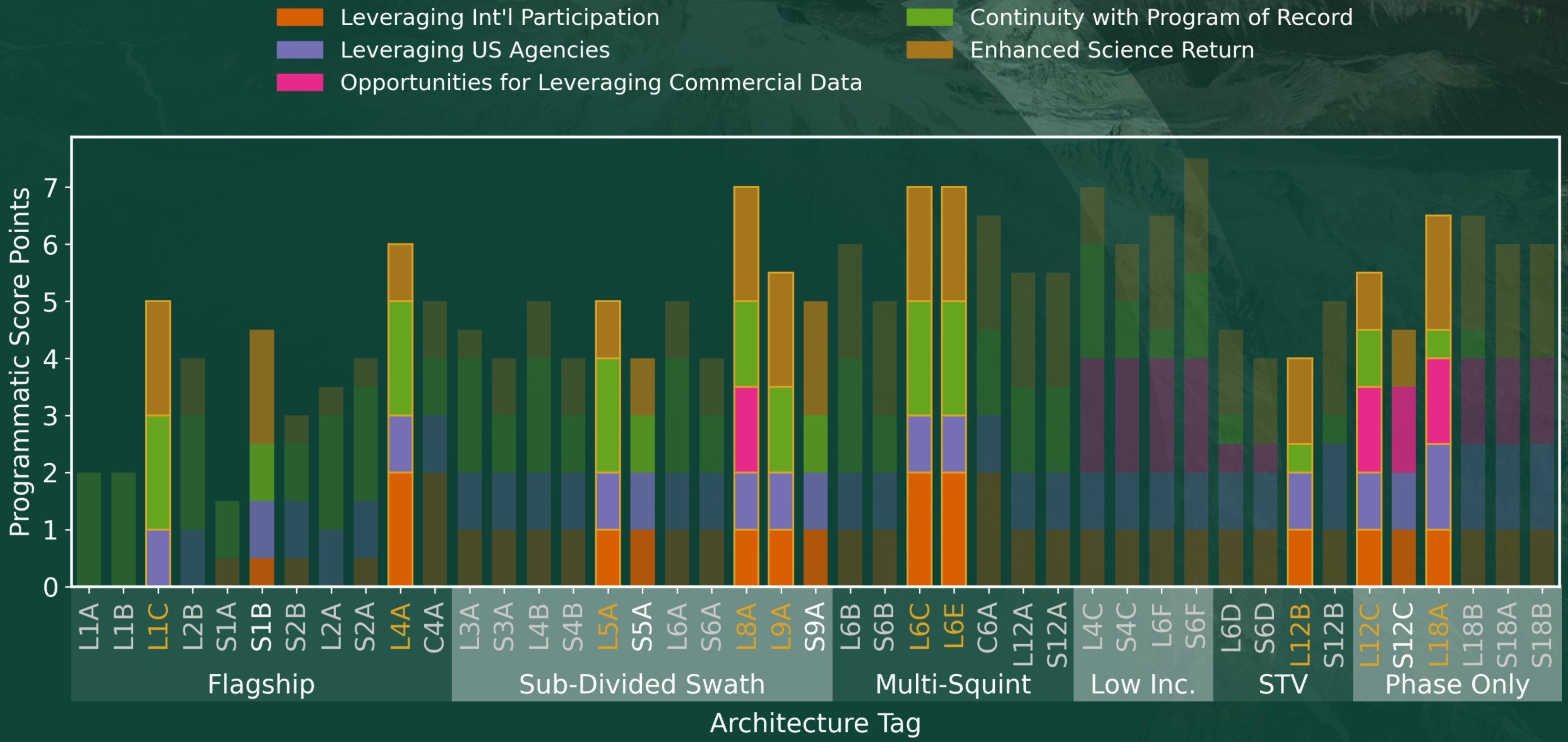






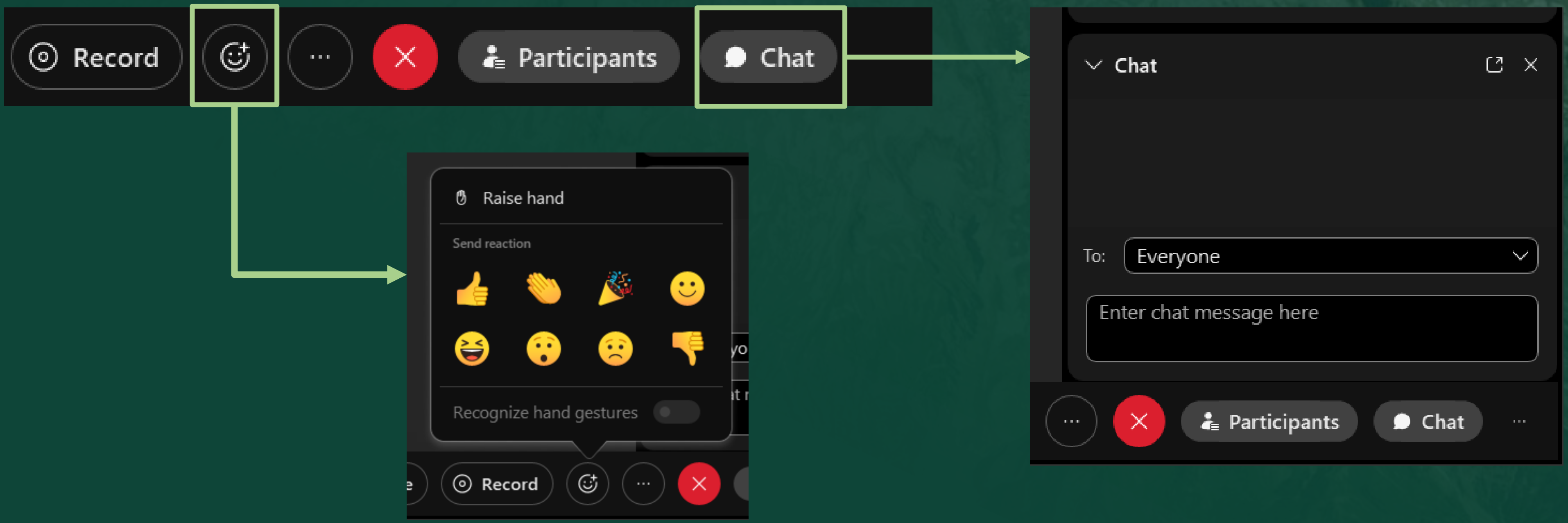


Programmatic



Community Conversation

Please provide a question in the chat box or raise your hand to be unmuted if you have a question or feedback for the SDC team.



EARTH SYSTEM OBSERVATORY

Keep Engaging with our SDC Study!

- Visit our SDC Study Team Webpage:
  - https://science.nasa.gov/earth-science/decadal-sdc

- Join the SDC email list for updates
  - Send an email to SDC-Community-join@lists.nasa.gov
  - You do not have to put anything in the subject line or the body.
  - Follow the instructions in the email to confirm.

- Keep updated on our 2022 activities, which include:
  - NISAR Community Workshop: https://sites.google.com/view/nisarscience2022/
  - PECORA https://pecora22.org/
  - AGU Fall Meeting 2022 SDC Town Hall https://www.agu.org/Fall-Meeting

SATM

Back-Up Slides

EARTH SYSTEM OBSERVATORY

List of Plots

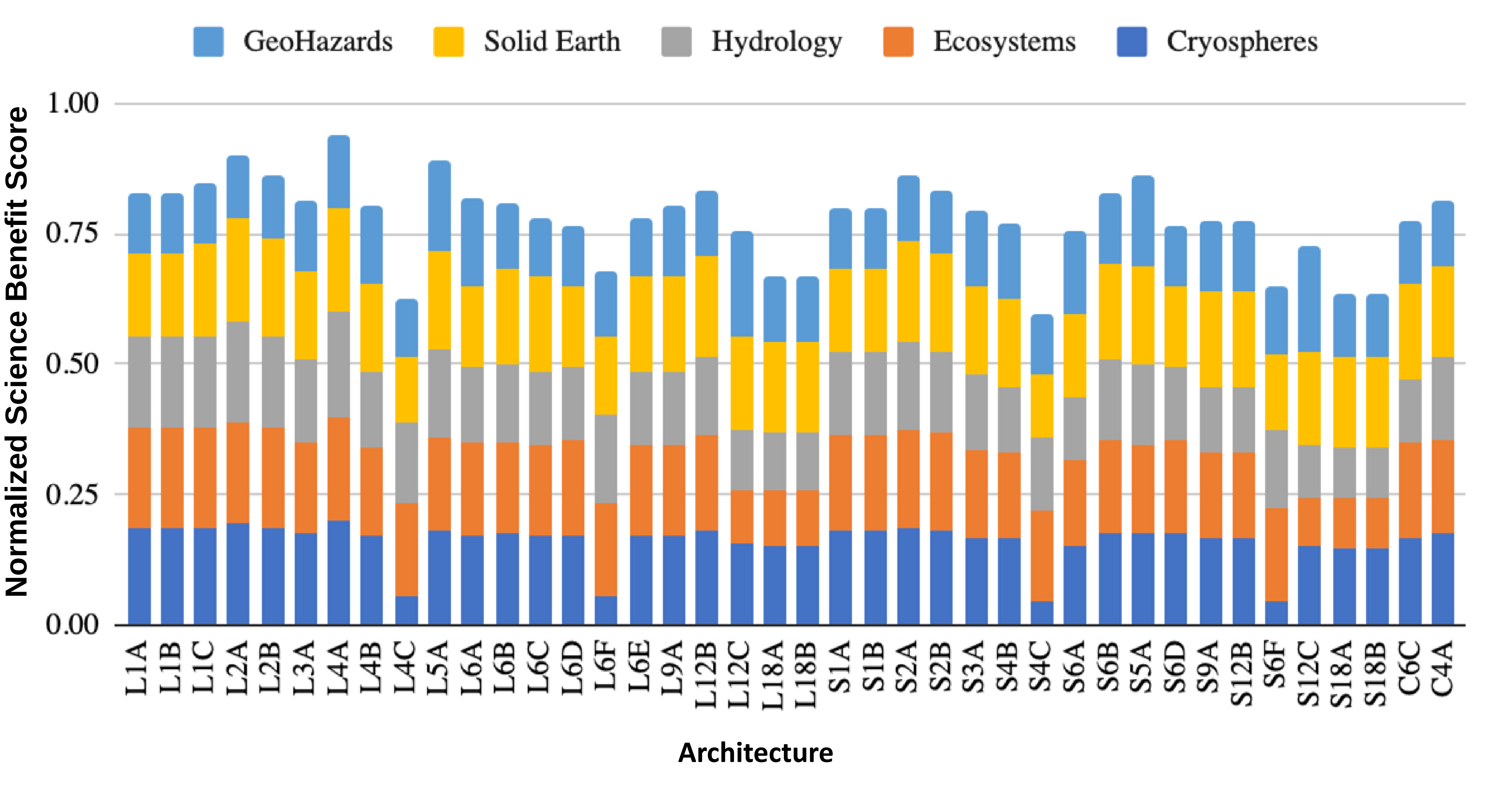
- ✓ Table of Selected Architectures
- ✓ Revisit vs # of sats and swath width
- ✓ Look diversity vs repeat time (from AGU)
- ✓ R&A Tables of Scores
- ✓ Color coded score table
- ✓ Benefit scores vs architecture
- ✓ Programmatic
- ✓ Cost vs coverage area

Science VF

Programmatic VF

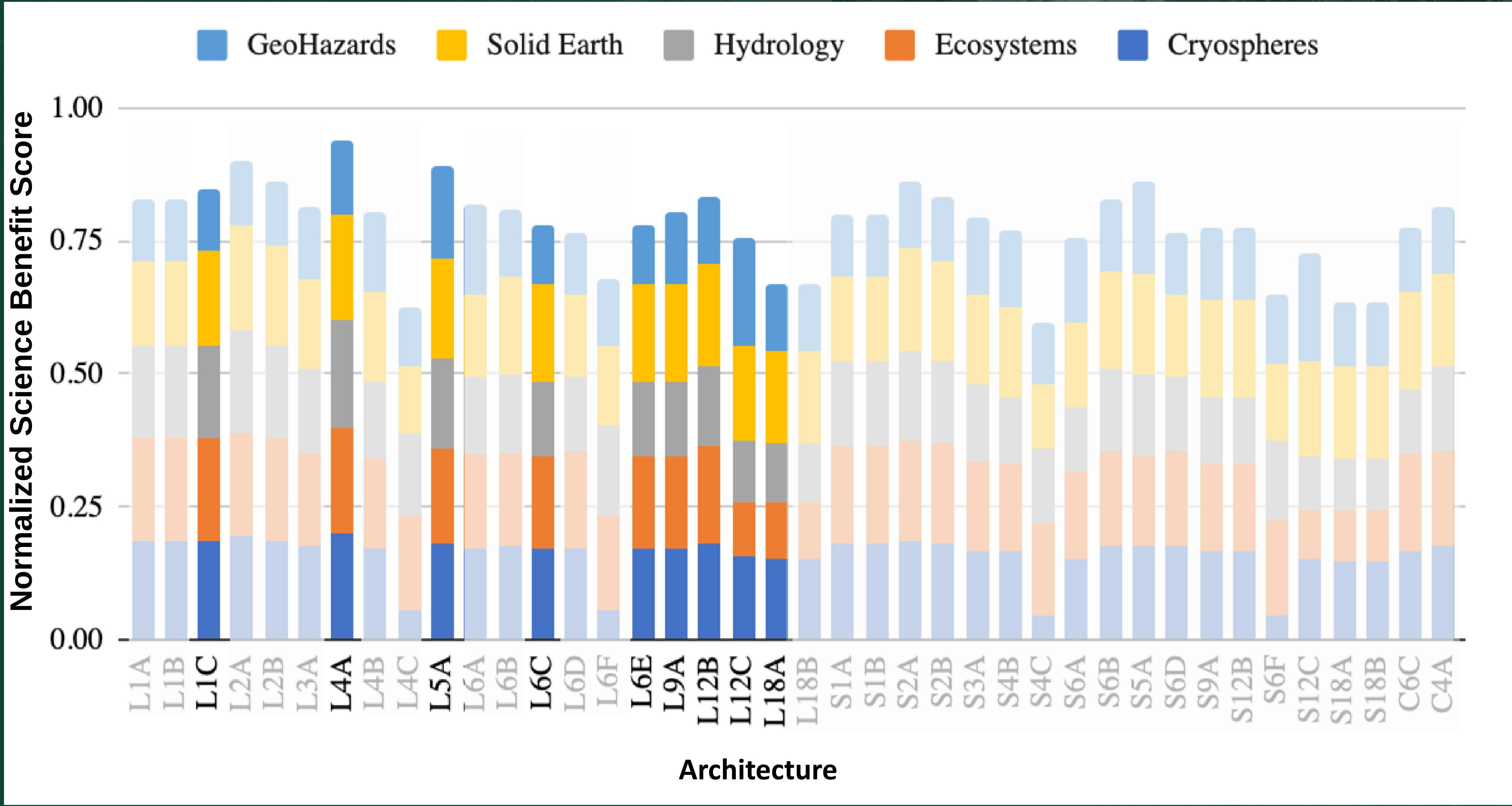
Cost VF

Science benefit scores vs. Architecture



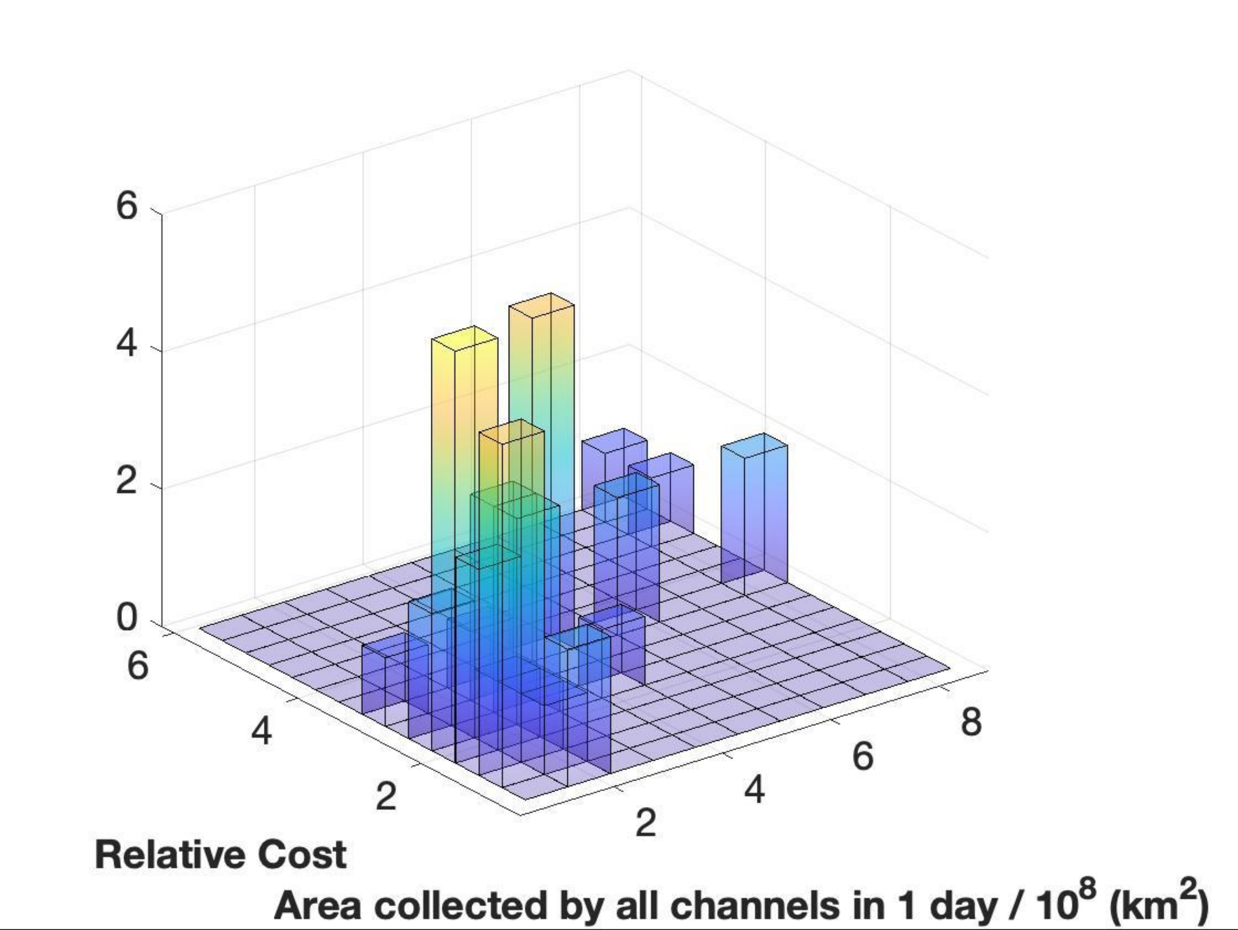
Science benefit scores vs. Selected Architecture

EARTH SYSTEM OBSERVATORY

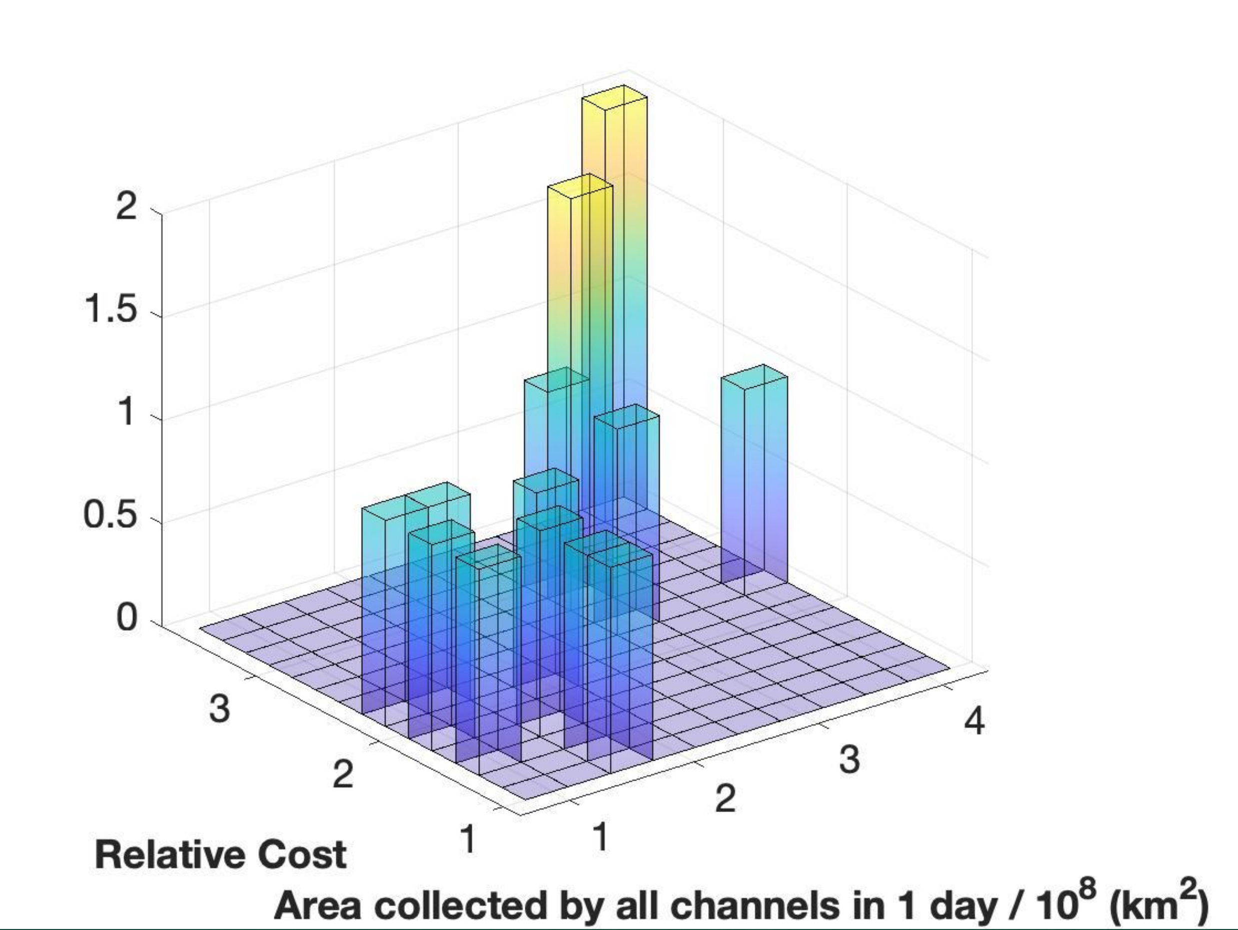


Relative cost vs. Area (What is the vertical axis?)

All Architectures



Selected Architectures



Top overall. Geohazards is average to poor. Quad pol. Flagships.	**Top in Hydrology / Ecosystems; good in Cryosphere; poor in Geohazards.** NISAR-Lite; same temporal sampling. Quad pol.	**Top in Geohazards.** Fast revisit, low cost/satellite.	**Average across FAs, with exceptions.** NISAR via multi-squint co-fliers.	**Average across FAs, with exceptions.**	**Poor in Cryosphere, Solid Earth and Geohazard. Above average in Hydrology and Ecosystems.** Lowered inclination orbits. Dual pol.	**Below average to poor across all FAs.** Multi-squint, low radiometric accuracy and duty cycle. Single pol. Low cost/satellite.
L4A 2 NISAR-like instruments to complement the 2 ROSE-L satellites. 3x NISAR's temporal sampling (4x over Europe, perhaps including Greenland and other parts of the Arctic. Top performer in Cryosphere, Solid Earth, Ecosystems and Hydrology. Average in Geohazards. **L2A S2A** 2 NISAR-like instruments at opposite ends of the NISAR orbital plane. Roughly equivalent to the ROSE-L concept. 2x NISAR's temporal sampling. Top performer in Cryosphere, Solid Earth, Ecosystems and Hydrology. Below average in Geohazards.	**L2B S2B L1B S1B** Missions are expected to achieve similar accuracies. L2B includes a co-flyer for atmospheric removal. L2B has above average performances in Solid Earth; L1B is below average. **L1C L1A S1A** L1C is NISAR with an atmospheric instrument (PWV), which can help meet the high accuracy requirements of Solid Earth and Geohazards. L1C performs better than L1A in those FAs.	**L12C S12C** Low radiometric accuracy and low orbital duty cycle. Disaster observation can be 12x NISAR. Single pol. Low SB scores in Ecosystems, Cryosphere and Solid Earth are mostly due to these constellations using low radiometric accuracy and low orbital duty cycle to lower the cost. Low duty cycle does not imply gaps in coverage, but less observations of points on the surface which would reduce accuracy. **L6A S6A** Six L-band or S-band satellites equally distributed around the NISAR orbital plane and covering 1/6 NISAR swath, resulting in the same temporal sampling as NISAR. Disaster observation can be 6x NISAR. Dual pol. Top performers in Geohazards. Poor in Solid Earth and average in the other FAs. **L5A S5A** Five L-band satellites equally distributed around a 10-day repeat orbital plane and covering 1/4 NISAR swath, resulting in 1.4x NISAR's temporal sampling. Disaster observation can be 6x NISAR. Dual pol. Does relatively well in Geohazards, and average in the other FAs.	**L6B S6B** Multi-squint formations covering 1/2 NISAR swath in NISAR orbit, resulting in the same temporal sampling as NISAR. Disaster observation can be 2x NISAR. Dual pol. Above average in Cryosphere. **L9A S9A** Multi-squint formations covering 1/3 NISAR swath in NISAR orbit. Same temporal sampling as NISAR. Disaster observation can be 3x NISAR. Dual pol. Average across all FAs. **L6C L6E** Multi-squint co-flyers surrounding the ROSE-L. Co-flyers are active (L6C)/passive (L6E). Targets both 3D deformation and atmospheric removal. Disaster observation can be 2x NISAR. Quad pol. Above average in Cryosphere. Poor in Geohazards. Average in the other FAs. **C6C** Multi-squint co-flyers surrounding a C-band zero-doppler instrument such as Sentinel-1. Above average in Ecosystems. Poor in Geohazards.	**C4A** 2 C-band instruments to augment the Sentinel-1. Would fly 90 deg out of phase with the current instruments in sentinel orbit. 3x NISAR's temporal sampling. **L12B S12B S6D L6D** Multi-baseline helical orbits operating in non-zero baseline (tomography mode) once every year for every point on the ground and shift to repeat pass interferometry rest of the time. Time in tomography mode decrease the accuracy. Each satellite covers 1/6 NISAR swath steered to zero doppler with adjacent swaths. Alternate modes would perform STV and cross-along-track interferometry objectives. L12B and S12B: 1.8x NISAR's temporal sampling; S6D and L6D: 0.8x NISAR's sampling. Dual pol. L12B: Good in Solid Earth. Above average in Ecosystems and Cryosphere. **L4B S4B** Four satellites equally distributed around the NISAR orbital plane and covering 1/4 NISAR swath. Same temporal sampling as NISAR. Mechanical steering can provide 4x NISAR's disaster sampling. Dual pol. Above average in Geohazards. **L3A S3A** Subdivided swath architecture for 1/3 NISAR swath. Same temporal sampling as NISAR. Disaster observation can be 3x NISAR. Dual pol. S3A: Above average in Geohazards.	**L4C S4C L6F S6F** Low SB scores, particularly in Cryosphere and Solid Earth, are mostly due to the lowered inclination orbit. Cryosphere needs to be covered through X-band commercial data purchases, if feasible. L6F and L4C: Good to above average in Hydrology and Ecosystems.	**L18A S18A L18B S18B** Low SB scores in Ecosystems, Cryosphere and Solid Earth are mostly due to these constellations using low radiometric accuracy and low orbital duty cycle to lower the cost. Low duty cycle does not imply gaps in coverage, but less observations of points on the surface which would reduce accuracy. Poor performance in Ecosystems is also due to single pol.

Top overall. Geohazards is average to poor.	Quad pol. Flagships.	**L4A** 2 NISAR-like instruments to complement the 2 ROSE-L satellites. 3x NISAR's temporal sampling (4x over Europe, perhaps including Greenland and other parts of the Arctic. Top performer in Cryosphere, Solid Earth, Ecosystems and Hydrology. Average in Geohazards. **L2A S2A** 2 NISAR-like instruments at opposite ends of the NISAR orbital plane. Roughly equivalent to the ROSE-L concept. 2x NISAR's temporal sampling. Top performer in Cryosphere, Solid Earth, Ecosystems and Hydrology. Below average in Geohazards.
Top in Hydrology / Ecosystems; good in Cryosphere; poor in Geohazards.	NISAR-Lite; same temporal sampling. Quad pol.	**L2B S2B L1B S1B** Missions are expected to achieve similar accuracies. L2B includes a co-flyer for atmospheric removal. L2B has above average performances in Solid Earth; L1B is below average. **L1C L1A S1A** L1C is NISAR with an atmospheric instrument (PWV), which can help meet the high accuracy requirements of Solid Earth and Geohazards. L1C performs better than L1A in those FAs.
Top in Geohazards.	Fast revisit, low cost/satellite.	**L12C S12C** Low radiometric accuracy and low orbital duty cycle. Disaster observation can be 12x NISAR. Single pol. Low SB scores in Ecosystems, Cryosphere and Solid Earth are mostly due to these constellations using low radiometric accuracy and low orbital duty cycle to lower the cost. Low duty cycle does not imply gaps in coverage, but less observations of points on the surface which would reduce accuracy. **L6A S6A** Six L-band or S-band satellites equally distributed around the NISAR orbital plane and covering 1/6 NISAR swath, resulting in the same temporal sampling as NISAR. Disaster observation can be 6x NISAR. Dual pol. Top performers in Geohazards. Poor in Solid Earth and average in the other FAs. **L5A S5A** Five L-band satellites equally distributed around a 10-day repeat orbital plane and covering 1/4 NISAR swath, resulting in 1.4x NISAR's temporal sampling. Disaster observation can be 6x NISAR. Dual pol. Does relatively well in Geohazards, and average in the other FAs.
Average across FAs, with exceptions.	NISAR via multi-squint co-fliers.	**L6B S6B** Multi-squint formations covering 1/2 NISAR swath in NISAR orbit, resulting in the same temporal sampling as NISAR. Disaster observation can be 2x NISAR. Dual pol. Above average in Cryosphere. **L9A S9A** Multi-squint formations covering 1/3 NISAR swath in NISAR orbit. Same temporal sampling as NISAR. Disaster observation can be 3x NISAR. Dual pol. Average across all FAs. **L6C L6E** Multi-squint co-flyers surrounding the ROSE-L. Co-flyers are active (L6C)/passive (L6E). Targets both 3D deformation and atmospheric removal. Disaster observation can be 2x NISAR. Quad pol. Above average in Cryosphere. Poor in Geohazards. Average in the other FAs. **C6C** Multi-squint co-flyers surrounding a C-band zero-doppler instrument such as Sentinel-1. Above average in Ecosystems. Poor in Geohazards.
Average across FAs, with exceptions.		**C4A** 2 C-band instruments to augment the Sentinel-1. Would fly 90 deg out of phase with the current instruments in sentinel orbit. 3x NISAR's temporal sampling. **L12B S12B S6D L6D** Multi-baseline helical orbits operating in non-zero baseline (tomography mode) once every year for every point on the ground and shift to repeat pass interferometry rest of the time. Time in tomography mode decrease the accuracy. Each satellite covers 1/6 NISAR swath steered to zero doppler with adjacent swaths. Alternate modes would perform STV and cross-along-track interferometry objectives. L12B and S12B: 1.8x NISAR's temporal sampling; S6D and L6D: 0.8x NISAR's sampling. Dual pol. L12B: Good in Solid Earth. Above average in Ecosystems and Cryosphere. **L4B S4B** Four satellites equally distributed around the NISAR orbital plane and covering 1/4 NISAR swath. Same temporal sampling as NISAR. Mechanical steering can provide 4x NISAR's disaster sampling. Dual pol. Above average in Geohazards. **L3A S3A** Subdivided swath architecture for 1/3 NISAR swath. Same temporal sampling as NISAR. Disaster observation can be 3x NISAR. Dual pol. S3A: Above average in Geohazards.
Poor in Cryosphere, Solid Earth and Geohazard. Above average in Hydrology and Ecosystems.	Lowered inclination orbits. Dual pol.	**L4C S4C L6F S6F** Low SB scores, particularly in Cryosphere and Solid Earth, are mostly due to the lowered inclination orbit. Cryosphere needs to be covered through X-band commercial data purchases, if feasible. L6F and L4C: Good to above average in Hydrology and Ecosystems.
Below average to poor across all FAs.	Multi-squint, low radiometric accuracy, and duty cycle. Single pol. Low cost/satellite	**L18A S18A L18B S18B** Low SB scores in Ecosystems, Cryosphere and Solid Earth are mostly due to these constellations using low radiometric accuracy and low orbital duty cycle to lower the cost. Low duty cycle does not imply gaps in coverage, but less observations of points on the surface which would reduce accuracy. Poor performance in Ecosystems is also due