Earth Science Division Decadal Survey Briefing with Stakeholders

Dr. Karen St. Germain
ESD Director

July 16, 2020

Questions Process

- This call is monitored by an operator
  - When you join the call, the operator will ask for your name
- When it is time for questions, please press *1 on your phone to indicate to the operator that you have a question
- The operator will introduce you by name and un-mute your line
  - Then you can ask your question and any follow up questions
- When done, the operator will re-mute your line and introduce the next person
- Please also email questions to **Amy Treat** at **Amy.A.Treat@nasa.gov** so we can post the question and its answer on our website

Outline

1. Earth Science Division Overview
2. Decadal Survey Update
3. Update of DOs
   - SGB – Surface Biology and Geology
   - ACCP – Aerosol, Cloud, Convection and Precipitation
   - MC – Mass Change
   - SDC – Surface Deformation and Change
4. Incubation Program
5. Cross Benefits of Applications and Research
6. Upcoming Calendar
7. Q&A
   - Please email questions to Amy Treat at Amy.A.Treat@nasa.gov; the operator will open phone lines for questions at the end of the presentation

Earth Science Division Overview

Mike Falkowski (SDC)

Laura Lorenzoni (SBG)

Paula Bontempi

Last Lecture – Thursday, August 6

ESD COVID-19 Update

ESD Research & Analysis Response to COVID-19: Rapid Response and Novel Earth Science

- Announced augmented funding for Rapid Response and Novel Earth Science (RRNES) element (A.28) in ROSES-19.
- 30 Proposals, mix of Research and Applied
- 7 Selections to date:
  - Near-Airport Changes in Column NO_2 and Formaldehyde during COVID-19 Pandemic Response and Recovery (Jennifer Kaiser, Georgia Institute of Technology; Elena Lind, Virginia Polytechnic Institute)
  - Generation of Imagery from OMI Data (Joanna Joiner and Bryan Duncan, Goddard Space Flight Center)
  - Inconsistent Effects of Social Distancing on Air Quality in Global Cities: Lessons for Protecting Near-Term Public Health and Designing Longer-Term Urban Transportation Policies (Susan Anenberg and Dan Goldberg, George Washington University)
  - Utilization of Night Lights To Look at Transportation/Relationship of COVID-19 Spread (Miguel Román, Earth from Space Institute)
  - Identify Shifting Emissions and Chemical Regimes (Kang Sun, University of Buffalo)
  - Analyze the Impact of Atmospheric Deposition on Aquatic Ecosystems/Water Quality (Maria Tzortziou and Brice Grunert, CUNY)
  - COVID-19 Human Activity Monitoring with Spaceborne SAR Observations (Sang-Ho Yun, JPL)
- Several additional tasks funded or augmented through existing programs.

COVID-19 Earth Observing Dashboard

https://eodashboard.org/

EARTH OBSERVING DASHBOARD WELCOME ABOUT

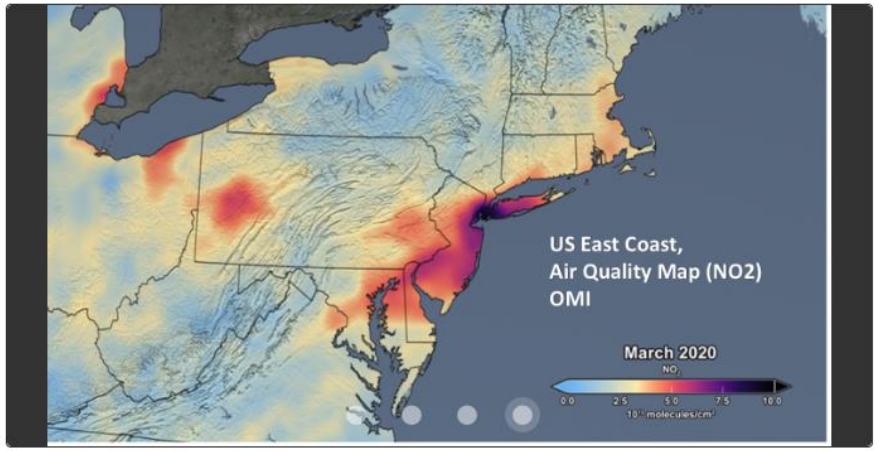
MAP TABLE

GLOBAL INDICATORS

12 5 9 12 4 5 9

-144.103, 28.613

COVID-19 Impact seen by Satellite



17 Economic Indicators

11 Agriculture Indicators

30 Environment Indicators

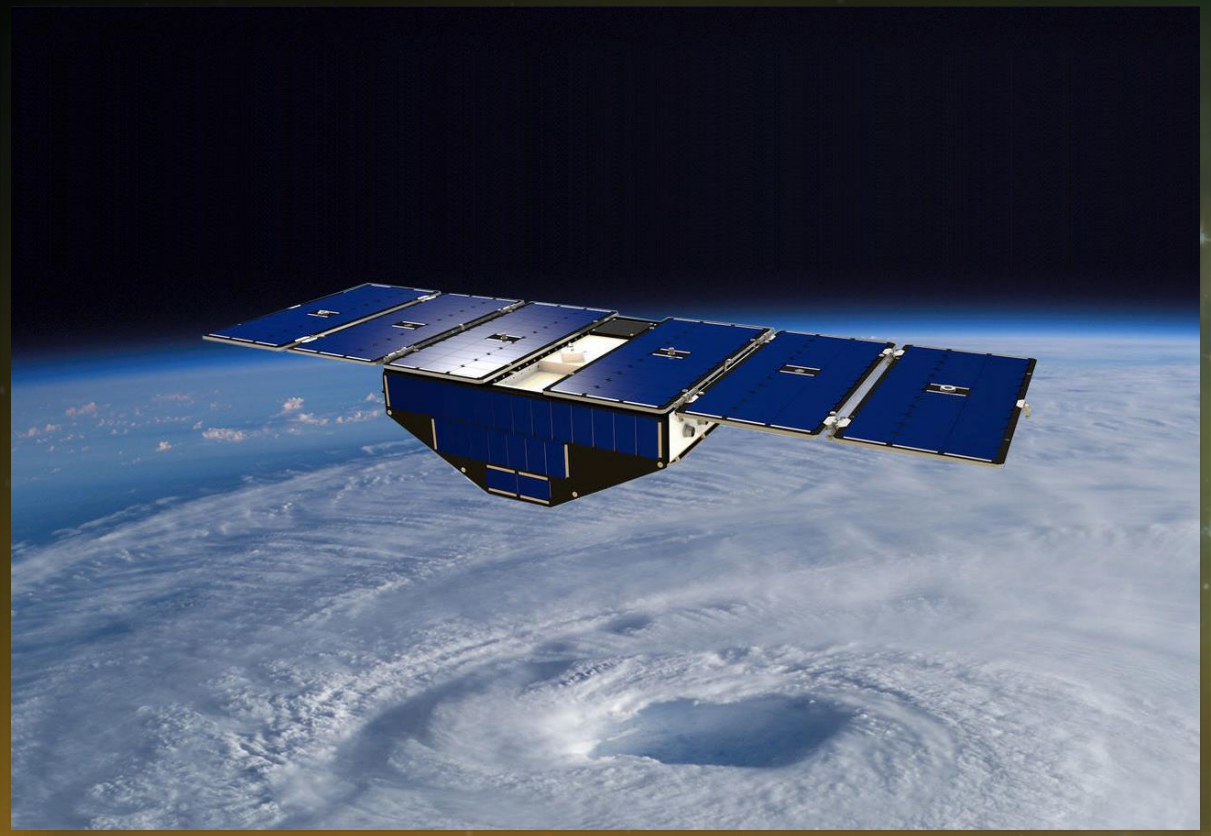
How to use the Earth Observing Dashboard

- Select INDICATORS and COUNTRIES from the lists
- Click on available data on the MAP, and in the TABLE
- Interact with the CHARTS, inspect the EO Data, learn more from the narratives and external resources
- To reset the map view, click on ALL COUNTRIES, ALL INDICATORS

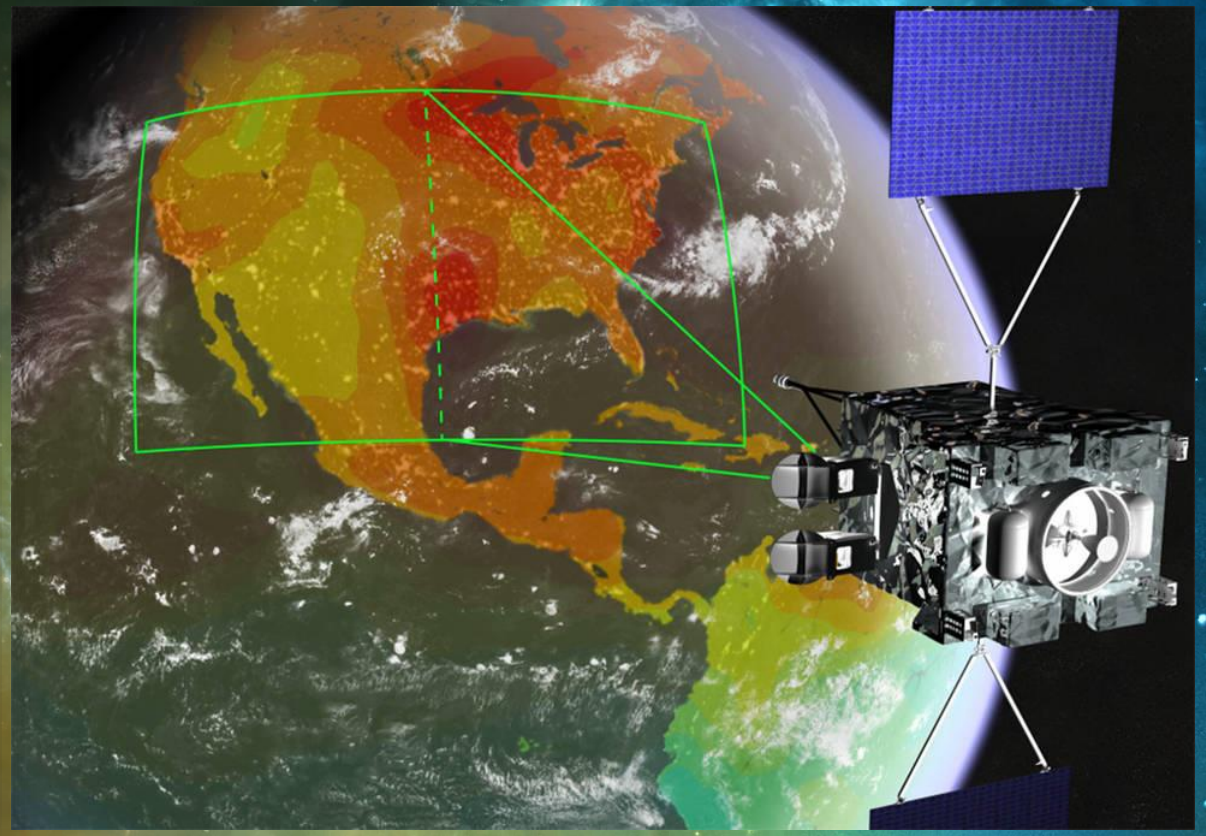
Color Legend

Better than As Worse than Upcoming Global

EVM-3 Announcement of Opportunity (AO)



EVM-1 (CYGNSS)

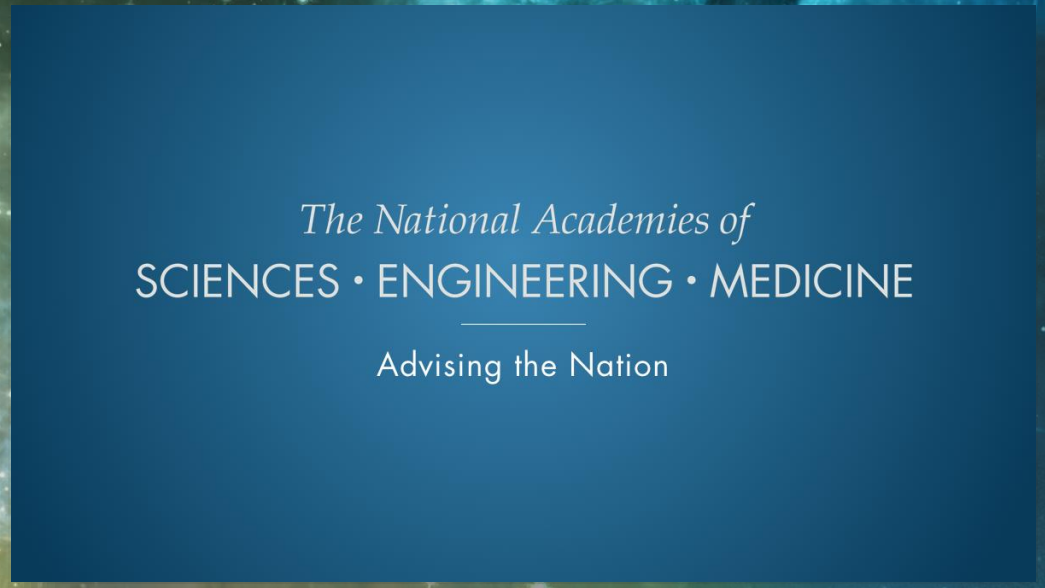


EVM-2 (GeoCarb)

Earth Venture & The National Academies

NASEM Workshop:
Lessons-Learned in the Implementation of the Earth Venture Mission (EV-M) and Earth Venture Instrument (EV-I)

The NASEM mid-term study:
Include a focused review of the Earth Venture Suborbital (EV-S) program as specified in the 2017 Decadal Survey.



Sentinel-6 Michael Freilich ◆ November 2020

Sentinel-6 Michael Freilich Environmental Testing Completed

Acoustic Test

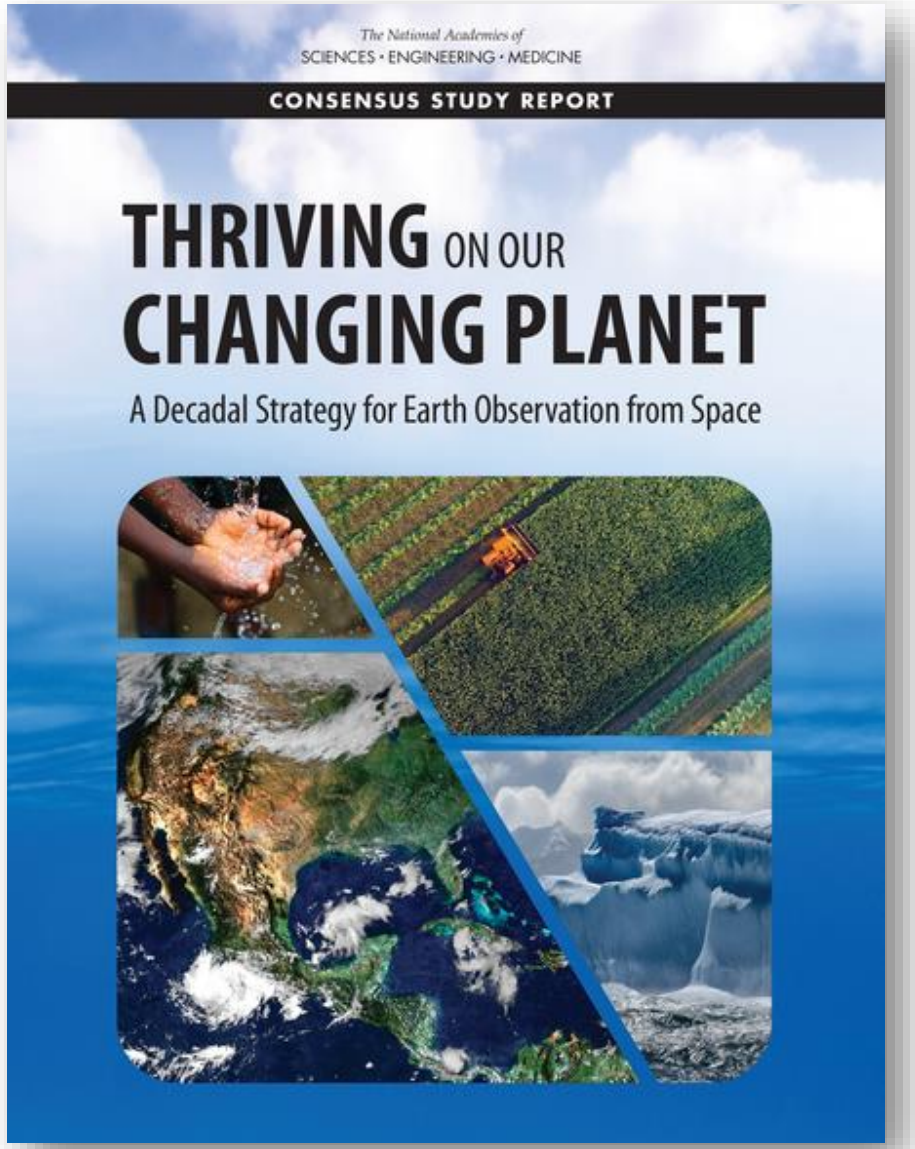
EMC/EMI Test

Decadal Survey Overview

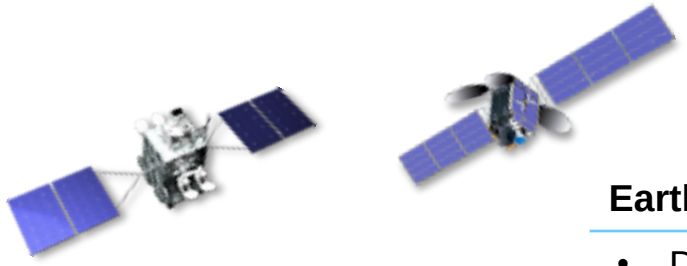
2017 Decadal Survey Snapshot

- Prioritizes observations rather than specific missions
- Identifies five “Designated” Observables
  - Aerosols; Clouds, Convection & Precipitation (ACCP)
  - Mass Change (MC)
  - Surface Biology & Geology (SBG)
  - Surface Deformation & Change (SDC)
- Introduces a new “Explorer” flight line
- Calls for “Decadal Incubation Program” on Planetary Boundary Layer (PBL) and Surface Topography and Vegetation (ST&V)

ESD is working with the community to translate the recommendations into an executable program and, for Flight, a portfolio of specific, realistic, launch-ordered missions and solicitations



2017 Decadal Survey Progress Highlights



Earth Venture-Continuity

- DS recommended new Earth Venture Continuity Measurement strand ($150M full mission cost cap)
- In December 2018, ESD released EVC-1 solicitation targeted for radiation budget measurements
- In February 2020, Libera (LASP) selected

Earth System Explorers

- DS recommended a new competed Explorer flight line with $350M cost constraint
- Implement 3 of 7 Targeted Observables
- Framework for program established
- Implementation on hold pending budget developments

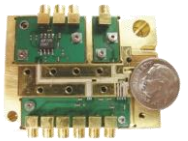
Designated Observables

- DS identified 5 Designated Observables (DOs) for mandatory acquisition

  In 2018 ESD initiated 4 multi-center DO studies, continued in 2019:
  - Combined: Aerosols-Clouds, Convection & Precipitation
  - Mass Change
  - Surface Biology & Geology
  - Surface Deformation & Change
- First DO Architecture Down Select by the end of Calendar Year 2020 to enter pre-Phase A
- Fully funds a DO project to be initiated in FY21, and initiates two more in FY23, and FY26

Decadal Incubation

- DS calls for Incubation Program to mature specific technologies for important — but presently immature — measurements (preparation for next Decadal)
- Solicitations for Study Teams (PBL and STV) released on March 14, 2019; selections made on December 3, 2019
- Decadal Incubation initiated and funded



DO Study Points of Contact

Study	Program Executive	Program Scientist	Program Applications Lead	Technology POC	Centers Study Coordinator
ACCP	Tahani Amer	Hal Maring (Alternates: Gail Skofronick-Jackson, Barry Lefer)	John Haynes (Alternate: David Green)	Amber Emory (Alternate: Bob Connerton)	Vickie Moran (GSFC)
SBG	Marissa Herron	Woody Turner (Alternates: Ben Phillips, Laura Lorenzoni)	Woody Turner (Alternate: Brad Doorn)	Bob Connerton (Alternate: Bob Bauer)	Jamie Nastal (JPL)
SDC	Mitra Dutta	Gerald Bawden (Alternates: Hank Margolis, Mike Falkowski)	Emily Sylak-Glassman	Bob Bauer (Alternate: Bob Connerton)	Paul Rosen (JPL)
MC	Amanda Whitehurst	Lucia Tsaoussi (Alternate: Jared Entin)	Brad Doorn	Bob Connerton (Alternate: Parminder Ghuman)	Bernard Bienstock (JPL)

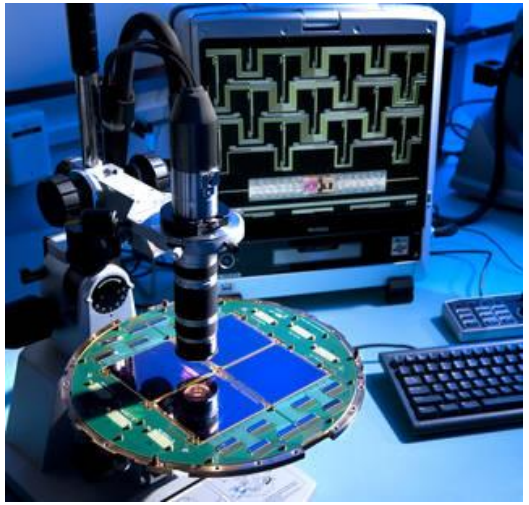
DO Industry Engagement: Updates on Solicitations

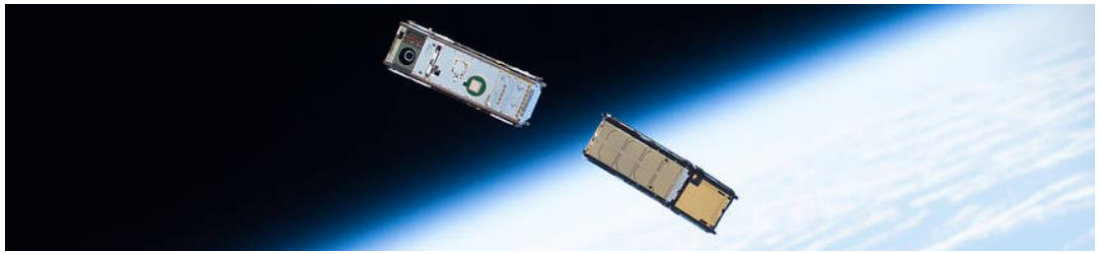
	Description	Supported Activity	Status
Category 1	Cross-Cutting Expertise in Specific Areas	All of the DOs	Underway
Category 2	Support to HQ	HQ Decadal Strategy	Pending
Category 3	Technology Demonstrations	Specific to each DO	Reporting by each DO study
Category 4	Applications Support	All of the DOs	Underway

Category 1: Cross-Cutting Support to DOs

JPL released the Category 1 solicitations in cross-cutting areas (i.e. capabilities that could apply to multiple DOs) where industry has unique expertise:

- SmallSat/CubeSat Constellations – **finalizing award**
- Payload hosting on Commercial Satellites – **finalizing award**
- Ground System Architectures – **proposal declared nonresponsive**
- Data Processing/Data Storage/Cloud Computing – **no proposals**
- Market Research on out-of-the-box enabling commercial technologies – **finalizing award**
- Research on non-traditional stakeholders and partnerships, such as philanthropists, non-profits, and foundations – **awarded and study underway**





Category 1: Foundations & Philanthropies

[Exploiting] external trends might include… nontraditional partnerships such as philanthropists and nonprofits *Decadal Survey, p. 63*

The Decadal Survey suggested leveraging external resources and trends, including possible partnerships with trusts, nonprofits, philanthropies, and foundations.

June 2020: Through JPL, NASA Earth began a contract with The Metropolitan Group to conduct a landscape assessment of foundations and trusts for possible partnerships across areas of Earth Science.

Metropolitan Group

Contract Summary

- Characterization of the Foundation Landscape
- Assessment of Potential Partners
- Engagement of Select Entities

Results expected in late-October 2020

Span of Use

In addition to support of the DOs, the results and potential partnerships may support activities across all of NASA Earth, including research, technology, diversity, applications, data systems, field campaigns, student support, etc.

Category 4: Applications Support to DOs

[Exploiting] external trends might include… commercial methods for characterizing the diverse applications and information end-uses of data; *Decadal Survey, p. 63-64*

The Decadal Survey suggested leveraging commercial methods, such as market research, to characterize user communities. ESD tasked new missions to have an Applications Plan based on a Community Assessment Report (CAR).

Spring 2020: NASA Earth began contracts with RTI International to support the DO Study Teams with characterizing applications user communities, developing the CAR, and expanding users beyond traditional, customary ones – particular focus on private sector industries.

ACCP / MC / SDC

- End-User Engagement
- User Community Characterization & Use Cases
- Support for development of the CAR

Contract through May 2021

SBG Contract

- End-User Engagement & Characterization
- Support for development of the CAR
- Special focus on input for Value Framework

Report expected September 2020

Surface Biology and Geology (SBG)

Mission Study on Surface Biology and Geology

SBG Science and Applications Objectives

Flows of energy, carbon, water, and nutrients sustaining the life cycle of terrestrial and marine ecosystems

Variability of the land surface and the fluxes of water, energy and momentum

Composition and temperature of volcanic products immediately following eruptions

Snow accumulation, melt, and spectral albedo

Inventory the world's volcanos and geology of exposed land surfaces

The global carbon cycle and associated climate and ecosystem impacts

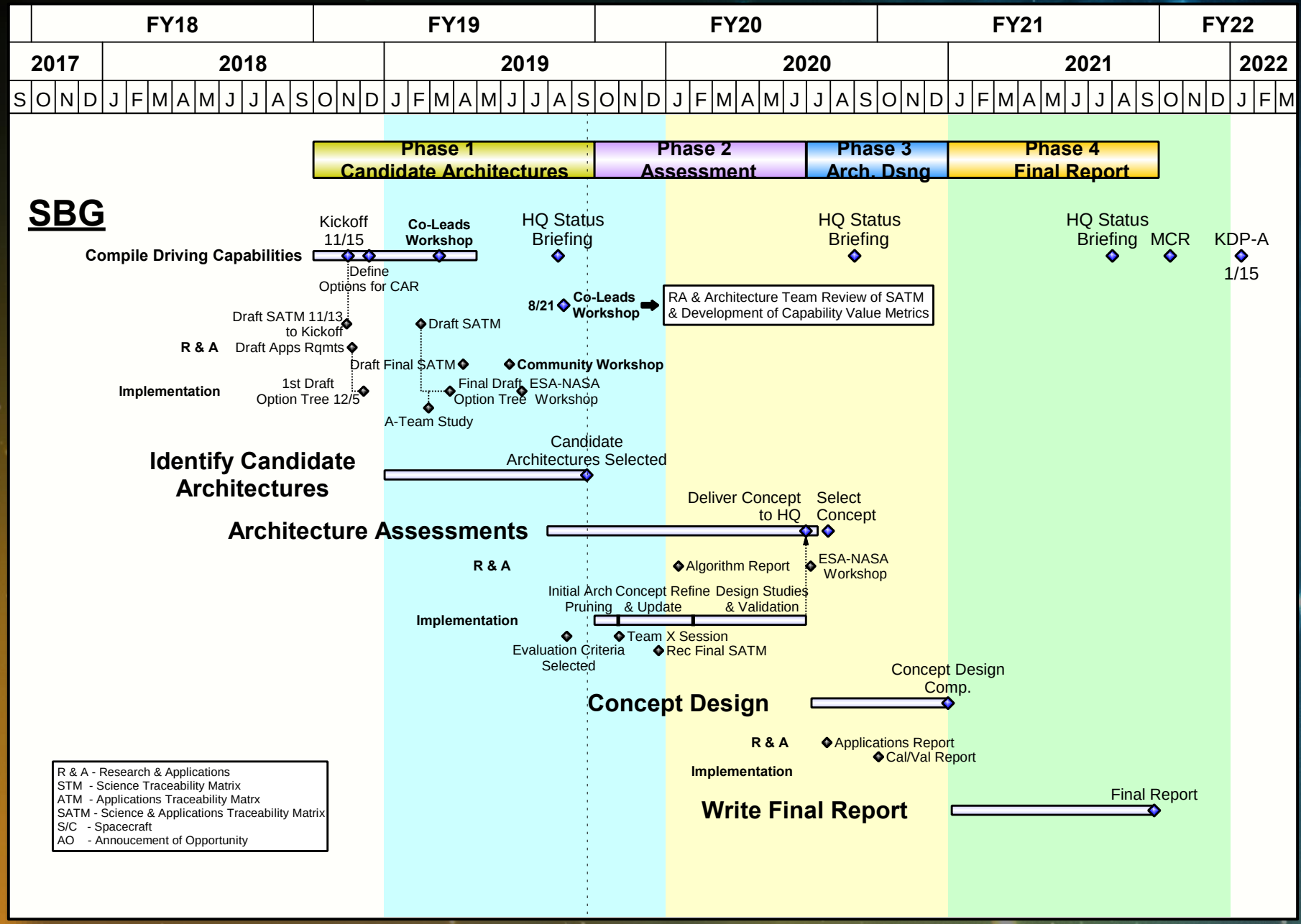
Monthly terrestrial CO_2 fluxes at 100 km scale

Land and water use effects, surface temperatures, evapotranspiration

Functional traits and diversity of terrestrial and aquatic vegetation

Water balance from headwaters to the continent

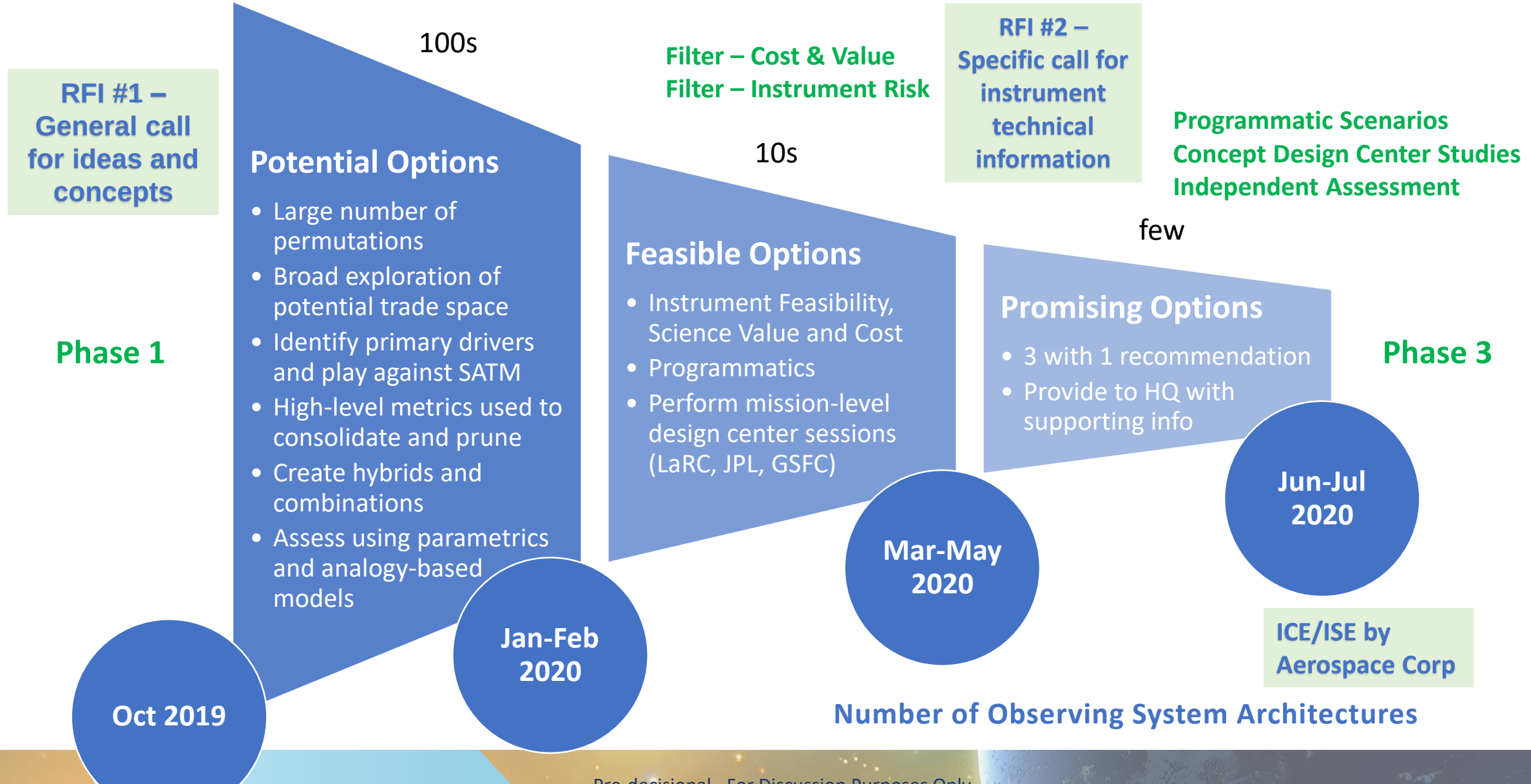
SBG Study Schedule



Surface Biology and Geology (SBG) Update

- Phase 2 Assessment of Architectures Wrapping Up
  - 6 Design Sessions at Multiple Centers (from ~61 Architectures to 3 Architectures)
  - Accomplished Virtually – Shows Innovativeness and Creativity of the Study Team
- RTI Applications Study Wrapping Up (>500 survey responses, > 40 interviews!)
- Conducted 3 Community Webinars (replacing workshop) 3/26, 5/27, 7/15
- July 15 Webinar: Logo Voting; Presentation of Recommended and Alternate Architectures to SBG Community (>300 participants)
- 2 Interim Checkpoint Reviews 5/4, 6/17
- SISTER Pathfinder and MEET-SBG OSSE Precursor Activities Underway
- July 29 Preferred Architecture Briefing to NASA HQ
- Study Final Report, MCR, and Phase A (Mission Formulation) in Fall 2021

Phase 2 Funnel - from “Many” to “Few”



Optimal SATM Performance Objectives

- Derived from the Decadal Survey and shown in the SATM
- Provided in the RFI to identify all candidate observing architectures

	Spectral Range	Spectral Resolution	Sensitivity	GSD	Revisit	Coverage	Local Time for Acquisition
VSWIR	0.35 or 0.4 to 2.5µm	10nm or better, Continuous coverage	VNIR >400 SWIR >250	30 m	8 days	Global	10:30-11:00
TIR	8 to 12µm 3 to 5µm	>5 Bands desired	NEdT <0.2 K	60m	1 days	Global	Afternoon

International Collaborations Are Essential to the SBG Observing System

- Developing potential Contributions for the SBG flight segments
  - **VSWIR**: ISRO – PSLV launch of a NASA VSWIR instrument/satellite + launch of a companion ISRO VSWIR instrument/satellite
  - **TIR**: ASI – Accommodation of a NASA TIR instrument and ASI VNIR camera on an ASI PLATINO+ satellite, ASI VEGA launch
- Cultivating Collaborations for coordinated on-orbit sampling strategies, product harmonization and fusion, and cal/val activities
  - **VSWIR**: CHIME (ESA), Unnamed (ISRO)
  - **TIR**: TRISHNA (CNES + ISRO), LSTM (ESA)
  - **Cal/Val**: Australian Space Agency, ESA, TERN, STRI
- Creating pre-SBG time series through the SISTER Pathfinder activity to better monitor Earth System change
  - **VSWIR**: HISUI (JAXA), DESIS (DLR), PRISMA (ASI), EnMAP (DLR), Sentinel-2 (ESA)
  - **TIR**: ASTER (JSS), Sentinel-3 (ESA)

Summary of Architecture Studies

	Recommendation: Two-Platforms	Alternate 1: One-Platform	Alternate 2: Constellation
Science value	7.56 out of 8	7.23 out of 8	7.56 out of 8
Applications value	Highest	High	Intermediate
Community assessment	Optimal	Acceptable	Unknown science risk (Cal/Val)
Risk	Schedule risk depends on partners	Complex development	Unknown level of science risk
NASA Cost (FY$18)*	600-650	700-800	700
Schedule - Launch Readiness Date	2026-2027	2027-2028	2026-2027
Comments	ASI VNIR for coincidence	Partial swath overlap	Cal/Val concerns
Conclusion	Exceeds science objectives, is within program scope with cost, schedule, and technical risk assessed to be acceptable and appropriate	Meets science objectives, with significant though manageable challenges for meeting targets, is within program scope with cost, schedule, and technical risk assessed to be appropriate	Meets science objectives, with significant though manageable challenges in meeting targets, is within program scope with cost and schedule, however assessed elevated science risk (Cal/Val)

* Best-case

SBG Phase 2 Schedule

	PHASE 2 ARCHITECTURE ASSESSMENT										PHASE 3	
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Team-X Initial Pruning	30											
Team-X SLI		10-11										
Bi-lateral HISUI		10-13										
Final SATM			15									
Algorithm Report			15									
Bi-lateral ASI- Italy				22-24								
Co-Leads Meeting DC				28								
HQ Follow-Up					26							
Bi-lateral Australia												
Bi-lateral ESRIN/CHIME						12-13						
Bi-lateral ASI/TIR						16-17						
Community Webinar						26						
Design Session, JPL							14-17					
Design Session, LaRC							14-18					
Design Session, JPL							28-30					
HQ Interim Checkpoint								4				
Design Session, GSFC								14-20				
Community Webinar #2								27				
HQ Interim Checkpoint 2									17			
ASI/TIR Deep Dive									16-18			
VSWIR Deep Dive										7-9		
Community Webinar #3										15		
Del Concept to HQ										29		
HQ Decision												

Successfully executed web-based Design sessions hosted by JPL, LaRC, ARC, GSFC

Changed Community Workshop to 3 Webinars

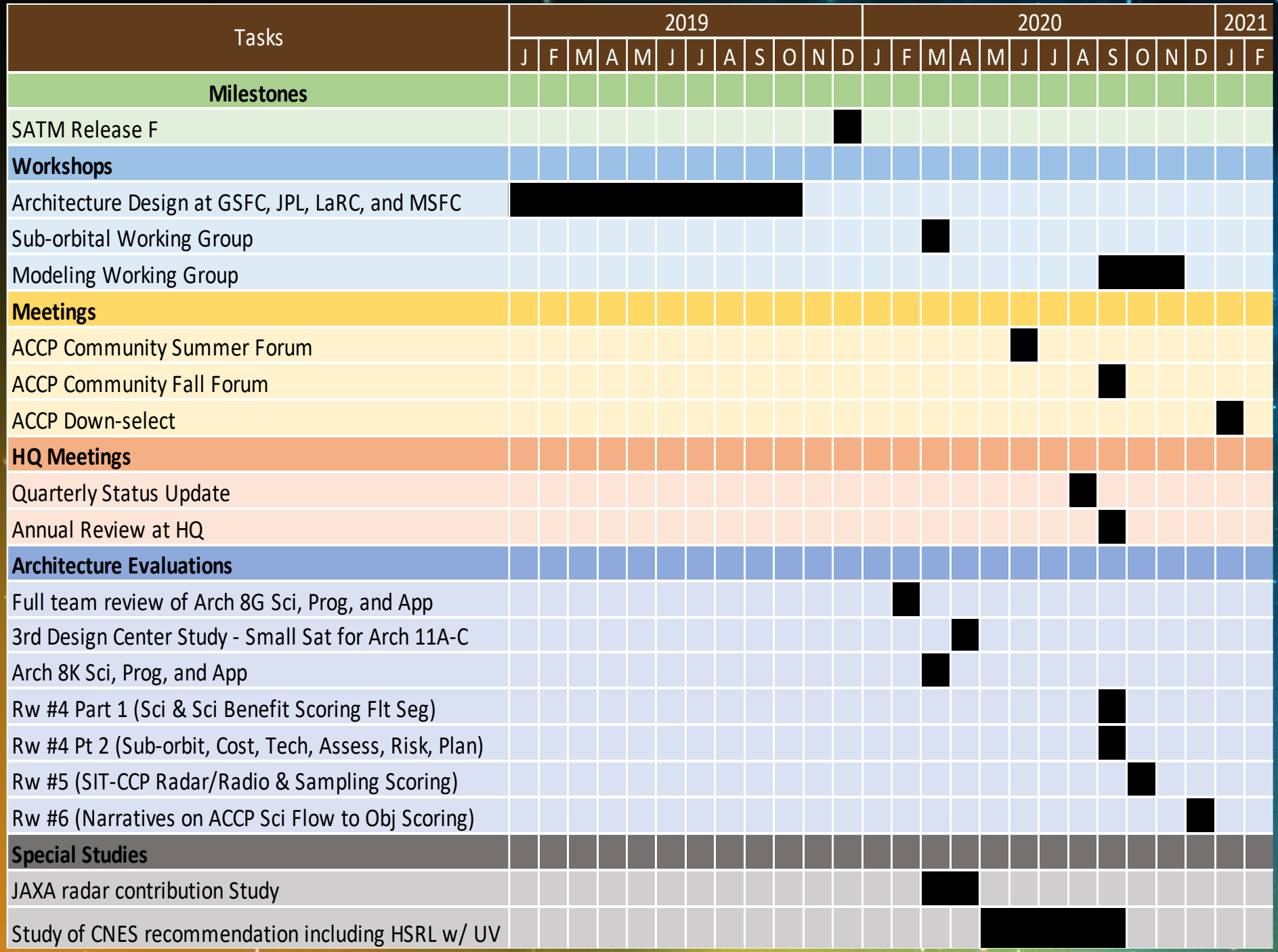
ASI Interface exchange rescheduled to June

Aerosol, Cloud, Convection and Precipitation (ACCP)

Mission Study on Aerosol and Clouds, Convection & Precipitation

ACCP Science Objectives

ACCP Schedule of Activities



Study Status Update and Upcoming Events

- Science and Applications Traceability Matrix (SATM) Release F, which will be used for scoring potential architectures released December 2019
- Architecture Design Workshops at GSFC, JPL, LaRC, and MSFC January-October 2019…
- Architecture Evaluations with Science Community Committee (SCC) February-December 2020 (iterative)
  - Full team review of Architecture 8G initial Science, Programmatic (Cost, Risk and Other Programmatic Factors), and Applications evaluations completed 12-13 February 2020 (updates planned)
  - 3rd Collaborative Design Center (CDC) Study started at MSFC (to be completed in April 2020) providing Small Sat building blocks for Architectures 11A-C
  - Architecture 8K Science, Programmatic, and Applications evaluations underway (scheduled to be completed in late March 2020)
  - Architecture Evaluation Review #4 Part 1 (Science & Science Benefit Scoring Flight Segment) 1-3 September 2020
  - Architecture Evaluation Review #4 Part 2 (Sub-Orbital, Cost, Technical Readiness Assessments, Risk, Plan Forward) 8-10 September 2020
  - Architecture Evaluation Review #5 (SIT-CCP Radar/Radiometer Scoring & Sampling Scoring per Objective) 14-15 October 2020
  - Architecture Evaluation Review #6 (Narratives on ACCP Science Flow To Objective Scoring) 2-3 December 2020
- Special studies (March to September 2020) to include JAXA radar contribution and CNES HSRL w/UV
- Sub-Orbital Working Group (SOWG) Workshop (~75 participants) 11-13 March 2020
- ACCP Down Select Meeting 27-28 January 2021

Study Status Update and Upcoming Events

- ACCP Quarterly Status Update to Headquarters August 2020
- Headquarters Annual Review 22-23 September 2020

Community Involvement

- ACCP Community Summer Forum 22 June 2020
- ACCP Community Fall Forum 29 September 2020
- ACCP Website: https://earth.gsfc.nasa.gov/missions/accp
- Science Community Committee recommendations (include radiation measurements, inclined orbit, Δ-t observations)
- Potential International partners (JAXA, DLR, CSA, CNES) involved
- Modeling Working Group Virtual Workshops “Bringing models and observations together for clouds and aerosols” – lead by Andrew Gettelman – 1st meeting Fall 2020

Mass Change (MC)

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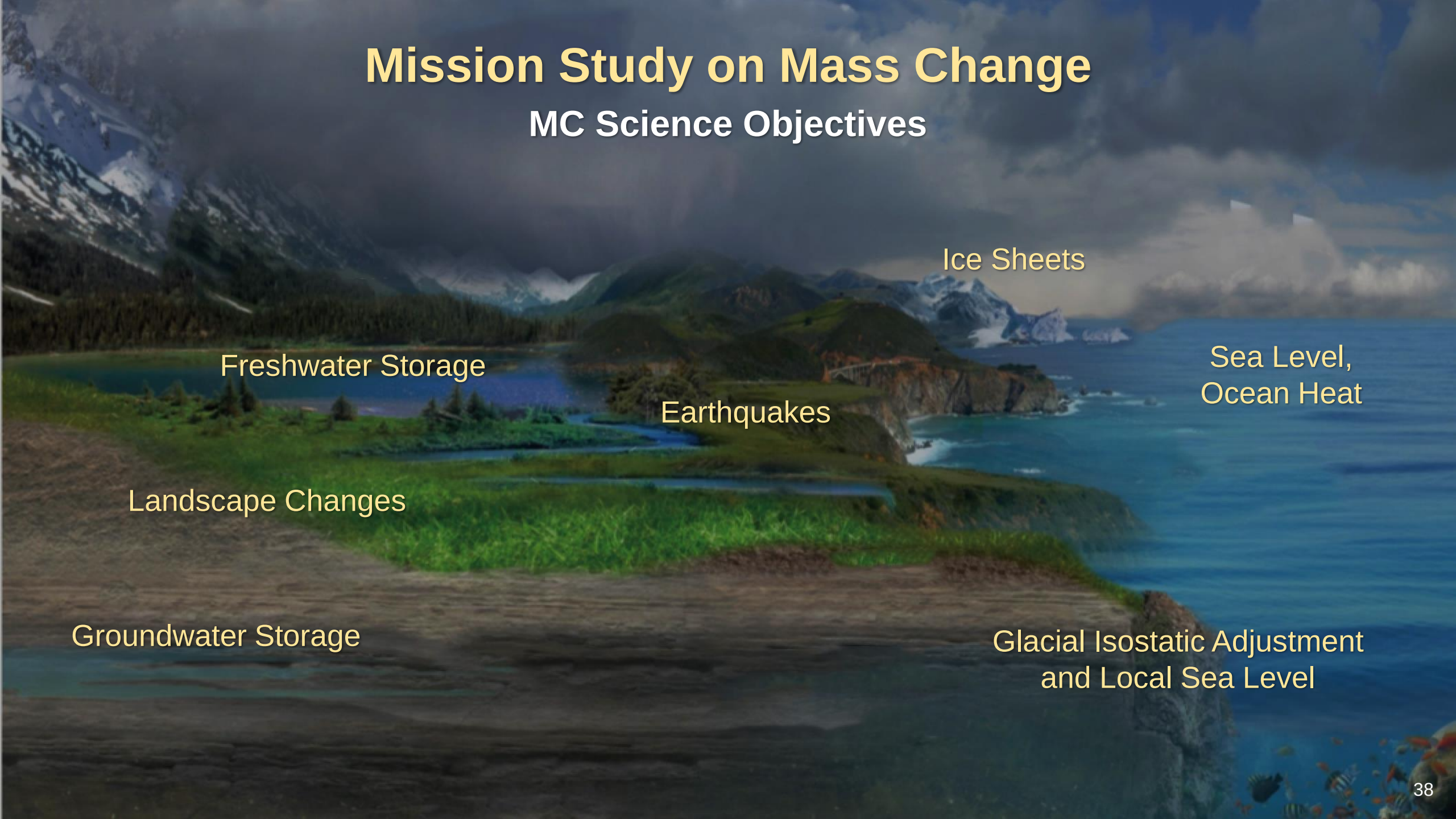
Mission Study on Mass Change

MC Science Objectives

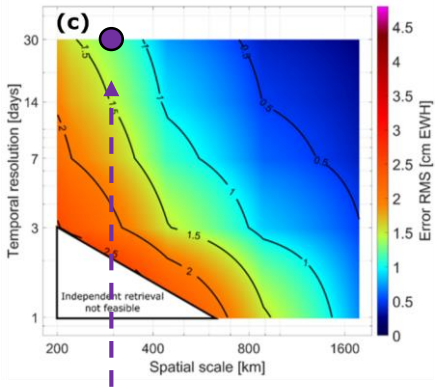


Mass Change (MC) Study Update

- Development of a **Value Framework** to assess identified observing architectures. The framework implemented utilizes the methodology developed by Hauk, M. and D. Wiese, 2020 "***New methods for linking science objectives to remote sensing observations: a concept study using single and dual-pair satellite gravimetry architectures***", Earth and Space Science, 7, e2019EA000922 doi:10.1029/2019EA000922. The work developed an approach for science value metrics, termed Space-Time-Accuracy-Grids (STAG), numerical simulation framework to simultaneously map the expected accuracy of a particular observing system architecture across space (200 km to 1800 km spatial scales) and time (daily to monthly scales).
- **Analysis of Alternatives (AoA)** - Assess the cost effectiveness of each of the studied architectures, utilizing the science value metrics (performance) together with risk, cost and schedule. Aerospace Corporation, with team input, analyzed and costed ~50 MC observing system architecture variants utilizing satellite-satellite tracking similar to GRACE-FO cost model. The analysis folded in results from a Team X study on 2 SmallSat architectures. Each architecture class included multiple configurations that traded various orbit parameters and instrument suites.
- Consider **continuity** of observations with GRACE-FO. Stochastic analysis provides a range of dates for GFO lifetime based on variation in solar flux predictions & considerations of GFO accelerometer transplant (decreased altitude).

Science Value Methodology

Architecture Performance

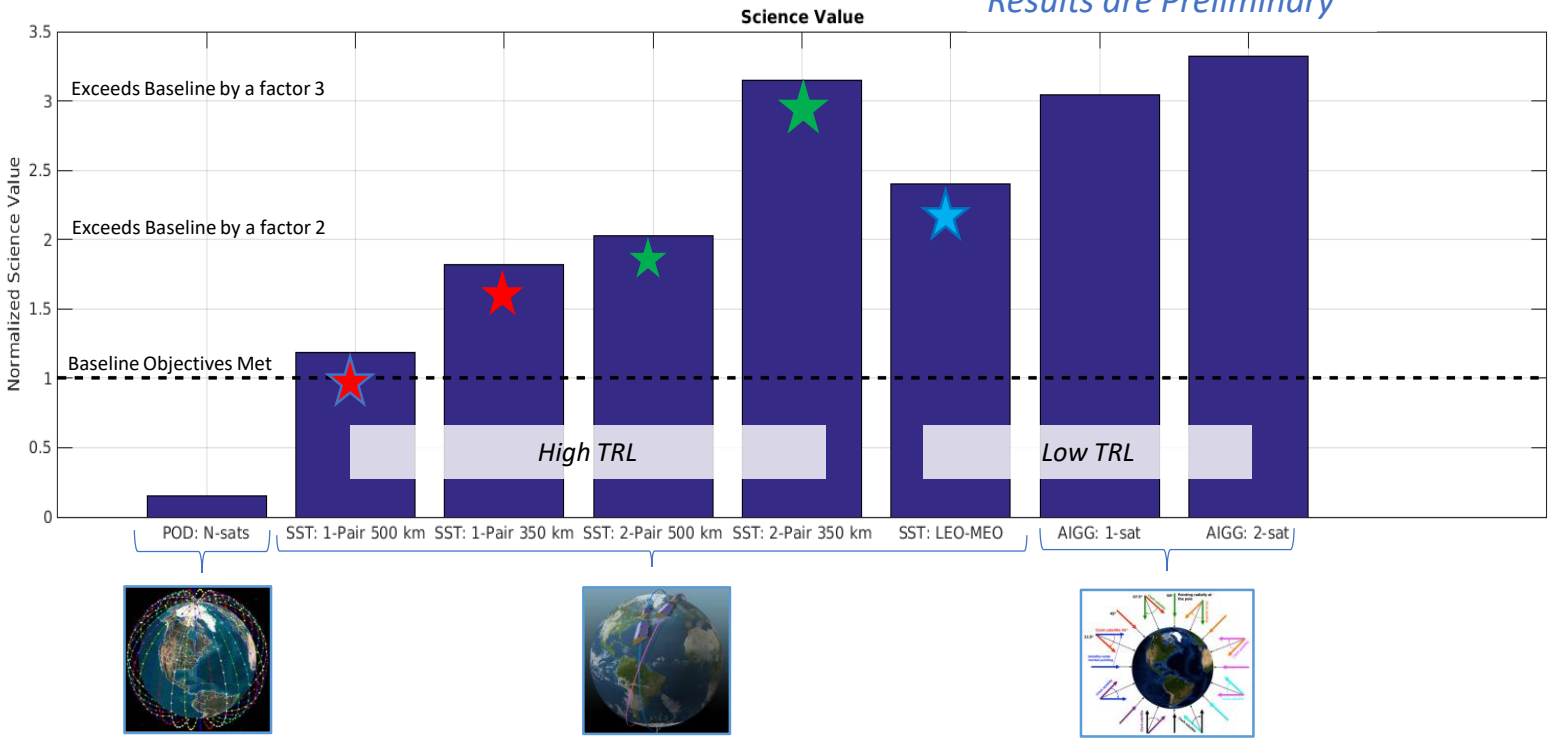


SATM

C-1d:
(300 km)²; 15 mm
Monthly

Architectures are assessed directly against performance targets in the SATM to provide a quantitative science value to each architecture

Results are Preliminary



★ **Discussions with Germany**
★ **Discussions with ESA**
★ **Discussions with CNES**

MCDO Technology Development

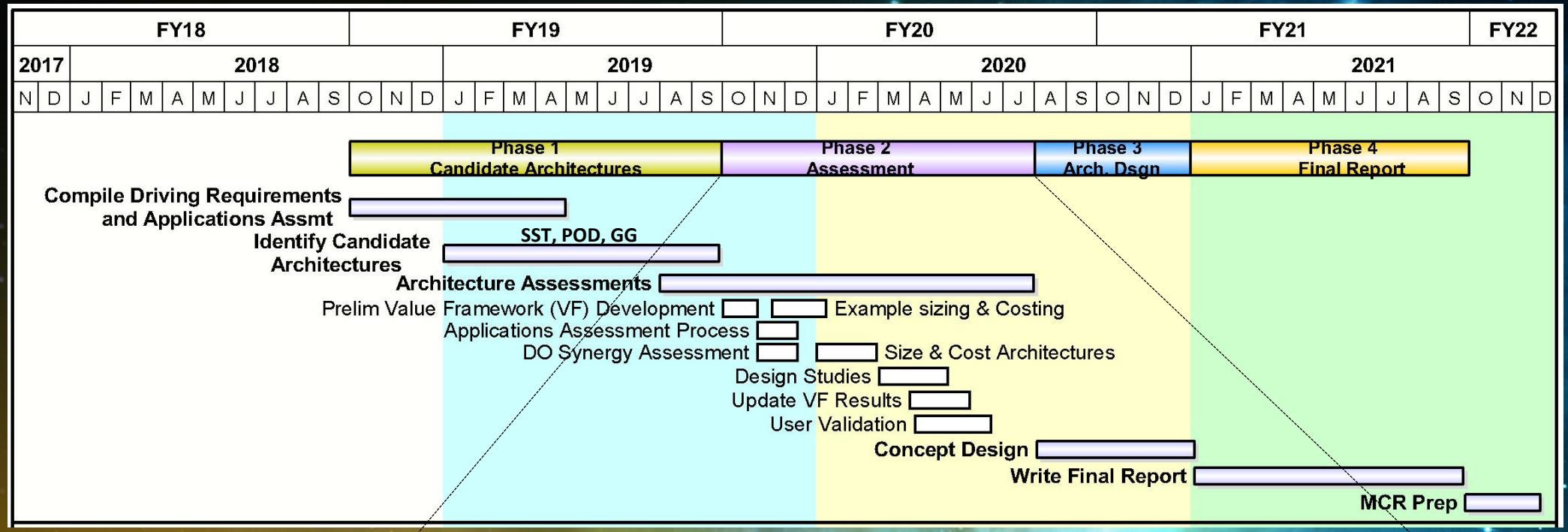
Technology development congruent with the MCDO study team and community priorities.

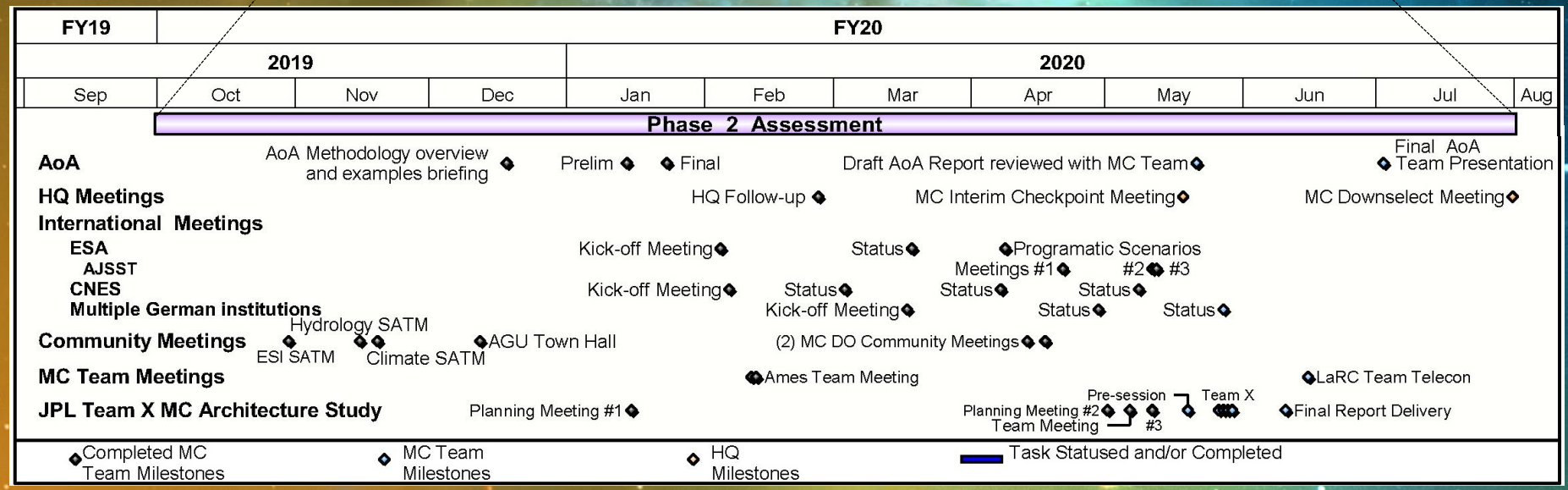
- **Laser Ranging Interferometer Technology Development for Primary Measurement – *SST architectures***
  - Ball Aerospace, Jennifer Lee, PI, $110k per year
  - Demonstrate ranging measurement enhancement enabled by optical frequency comb
  - LRI redundancy concept designs including Triple Mirror Assemblies and Optical Bench
  - Advancement of laser frequency reference cavity focusing on reduced volume and performance

- **Compact Optomechanical Accelerometer – *SmallSat/CubeSat SST N-pair for advanced spatiotemporal resolution***
  - Felipe Guzman, PI, LASS @ Texas A&M, $150k per year
  - Performance advancement and technology readiness of compact optomechanical accelerometers suitable for CubeSat implementation
  - Includes performance modeling, measurement characterization, improved packaging for flight, advancements of driving and processing electronics, and performance measurements

- **SmallSat/CubeSat SST constellation – *SmallSat/CubeSat SST N-pair for advanced spatiotemporal resolution***
  - GeoOptics, Tom Yunck, PI, $248k per year
  - Advancement of micro-sat based constellation gravity mission hardware and implementation
  - Includes mass trim mechanism, modified ADCS, thermal design stability improvement, CG calibrating, propulsion system selection, and final internal system layout

Mass Change Schedule





AoA = analysis of alternatives
SST = satellite-to-satellite tracking
POD = precise orbit determination
GG = gravity gradiometer

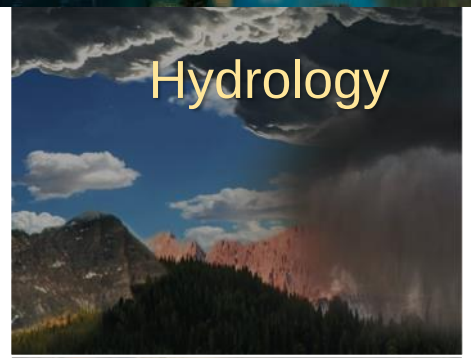
Partner Engagement

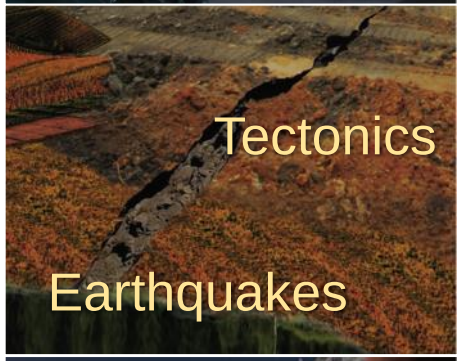
- **ESA:** NASA & ESA letter exchange for joint studies and the development of mission requirements document for a potential joint future mission implementing Bender constellation. ESA Phase 0 study complete, Phase A initiates next year. ESA prepares for a successful 2022 Ministerial such that Phase B can initiate (Bender constellation).
  - Held 3 technical forum meetings - Accelerometers/Sensors, Drag compensations system, Laser Ranging Instrument (LRI)/ Laser Metrology Instrument (LMI)
  - Established Ad hoc Joint Science Study Team (10 members) to consolidate the targets/requirements for the joint constellation based upon existing material and potential for future (prototype) services. Held several working meetings.
- **Germany** (HGF/GFZ, DLR, MPI, AEI): GRACE-I initial study of a few months to complete this summer. Considering “baseline mission on GRACE-FO and add-on of the ICARUS payload (animal tracking). Next phase to consider further technology options.
- **CNES:** Phase 0 study began January 2020 on the MARVEL constellation design, targeting ITRF in addition to MC. Held regular team meetings every 3 weeks. Challenges with LEO-MEO ranging and laser payload discussed.

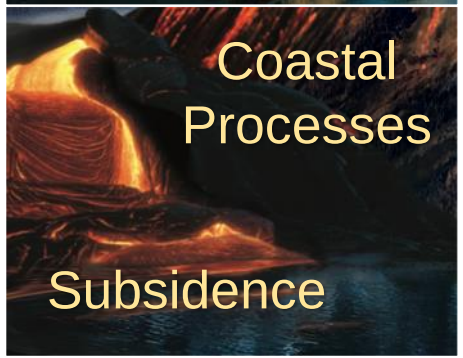
Surface Deformation and Change (SDC)

Surface Deformation and Change Observables

SDC Science Objectives







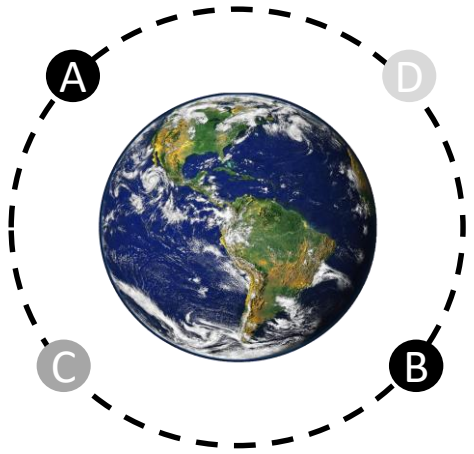
Unique Aspects of Surface Deformation and Change (SDC) Designated Observable Study

- An affordable synthetic aperture radar-based system or systems that would meet the Decadal Survey recommendations – *geodetic measurements*
- *Added study observables: Assess non-geodetic measurements and downstream sciences in the trade space (i.e. ecosystems, soil moisture, hydrology), though not emphasized in Decadal Survey*
  - *Requires additional exploration of SATM*
- Study Duration: *5 Years*
  - *Complicates the engagement with commercial and international partners which can be quite dynamic*
  - *Still 1-2 years away from down-selection*
- Engagement: There are literally dozens of potential *partnerships*, data sources, alliances, domestic and *international*

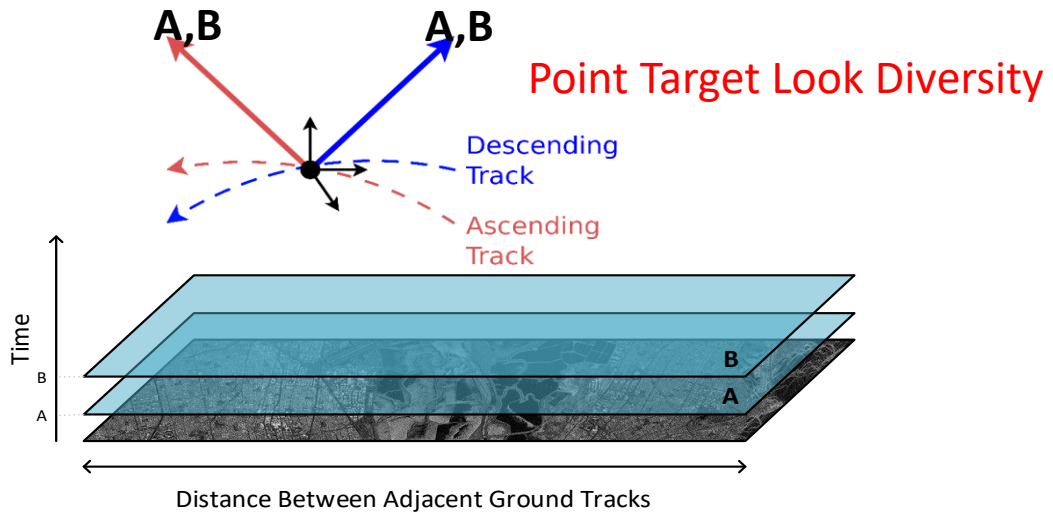
Major SDC developments since last Community Forum

- Kicked off SDC/ROSE-L (ESA) white paper development
- Kicked-off technology development to build/test integrated waveform generator
- Executed an RFI for Global Coherence Map and received good responses
- Socialized new technology roadmap with ESTO
- Kicked off SDC engagement with RTI – promising interaction. Exploring extent of engagement required
- Continued to mature architecture trade space and value framework definition

Architecture Candidate



Orbital Plane Spacing



Point Target Look Diversity

Ground Track Spacing

Capability ranking feeds into value framework

Capability	Ranking
Continuity	
Coverage	
Error Reduction	
Look Diversity	

Recent Community Engagement Activities

Surface Deformation and Change (SDC)
Designated Observable Study Plan
2017 Earth Science Decadal Survey

Community Workshop
Surface Deformation and Change

SAVE THE DATE

May 19-21, 2020
California Institute of Technology, Pasadena, CA

Shape the future of synthetic aperture radar (SAR) research and applications following the 2017 Decadal Survey as an advocate for your community's needs, priorities and desired characteristics of observations.

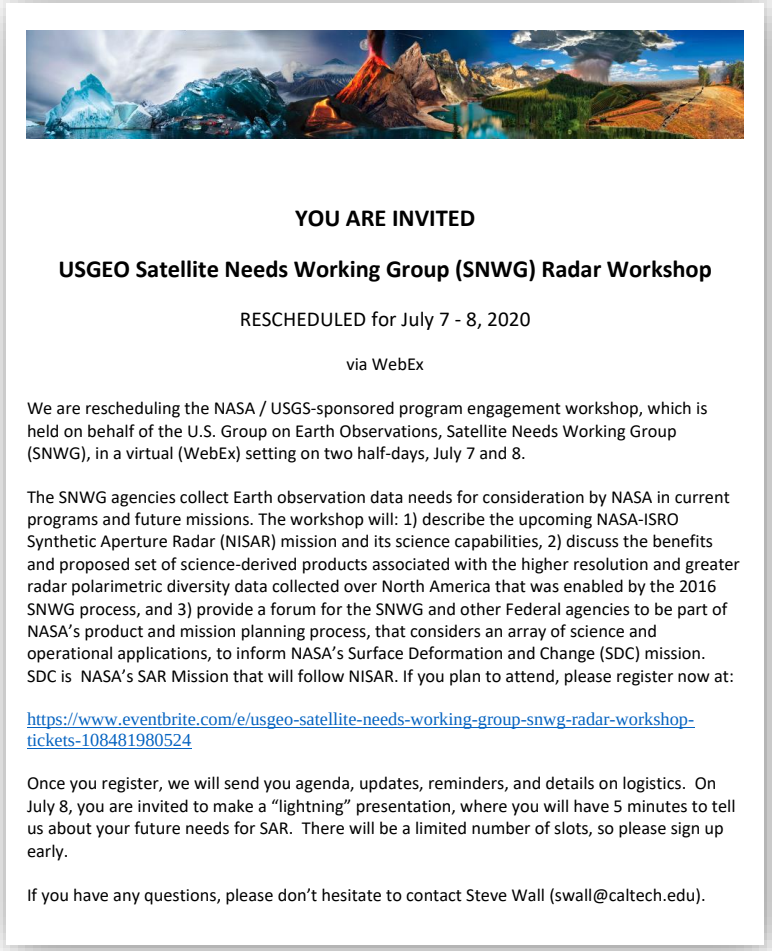
We invite you to join us for our 2020 Community Workshop to:

- ***Present*** your research and applications to demonstrate the crucial contributions of current and future SAR missions.
- ***Refine*** the science and applications goals for SDC to inform the needs for specific observations acquired through potential supporting architectures.
- ***Finalize*** discussions initiated in our 2019 Research and Applications Workshop (), Technology Workshop () and AGU Town Hall session ().

This workshop will be the last chance to discuss and share your thoughts before the SDC Study Team develops potential concepts for observing architectures and strategies. Be there!

For more information: *Ala Khazendar (ala@pl.nasa.gov)*
Andrew Molthan (andrew.molthan@nasa.gov)
NASA SDC Team

Research/applications community refinement of the SATM



YOU ARE INVITED

USGEO Satellite Needs Working Group (SNWG) Radar Workshop

RESCHEDULED for July 7 - 8, 2020

via WebEx

We are rescheduling the NASA / USGS-sponsored program engagement workshop, which is held on behalf of the U.S. Group on Earth Observations, Satellite Needs Working Group (SNWG), in a virtual (WebEx) setting on two half-days, July 7 and 8.

The SNWG agencies collect Earth observation data needs for consideration by NASA in current programs and future missions. The workshop will: 1) describe the upcoming NASA-ISRO Synthetic Aperture Radar (NISAR) mission and its science capabilities, 2) discuss the benefits and proposed set of science-derived products associated with the higher resolution and greater radar polarimetric diversity data collected over North America that was enabled by the 2016 SNWG process, and 3) provide a forum for the SNWG and other Federal agencies to be part of NASA's product and mission planning process, that considers an array of science and operational applications, to inform NASA's Surface Deformation and Change (SDC) mission. SDC is NASA's SAR Mission that will follow NISAR. If you plan to attend, please register now at:

https://www.eventbrite.com/e/usgeo-satellite-needs-working-group-snwg-radar-workshop-tickets-108481980524

Once you register, we will send you agenda, updates, reminders, and details on logistics. On July 8, you are invited to make a "lightning" presentation, where you will have 5 minutes to tell us about your future needs for SAR. There will be a limited number of slots, so please sign up early.

If you have any questions, please don't hesitate to contact Steve Wall (swall@caltech.edu).

Federal Agency input on potential research/ application needs that could be supported by SDC

Opportunities

- Partnerships to meet cost guidelines
  - SDC's strategy is to identify opportunities to align NASA schedule with potential partners' schedules
  - ***SDC team is developing a white paper with ESA ROSE-L team to describe SDC and ROSE-L synergistic possibilities***
- SDC has the potential to influence the development of the commercial sector, which is evolving rapidly
  - SDC is developing a model to assess future commercial capabilities and costs
- Science and applications for SAR/InSAR are broad and deep
  - NASA recognizes opportunities beyond the decadal survey recommendations and directed SDC to include these in the architecture trade space
  - Diverse communities have diverse observational needs leading to additional needed capabilities
    - Some high-resolution and targeted; others low resolution and global
    - Most demand fast temporal sampling
    - Polarimetric diversity, interferometric baseline diversity, wavelength diversity
  - ***Satellite Needs Working Group Interactions can help quantify value for applications***

Incubation Program Updates

PBL Study Team Update

- Weekly Study Team meetings + bi-weekly HQ tag-ups (virtual)
  - Leads: Joao Teixeira, Jeff Piepmeier, Amin Nehrir
  - 14 total Study Team members funded by NASA HQ
- Identified subgroups for science question theme areas
  - PBL and Extreme Weather / Convection
  - PBL and Clouds
  - PBL and Surface Interaction
  - PBL Vertical Mixing and Atmospheric Composition
- Outlined white paper structure (initiated writing assignments)
- Outlined SATM
- Interim report to NASA HQ in August 2020
- PBL Website being developed

PBL INCUBATION: A WHITE PAPER OUTLINE

1. MOTIVATION
2. DECADAL SURVEY
3. WORKSHOP
4. PBL SCIENCE
5. PBL APPLICATIONS
6. PBL MODELING AND DATA-ASSIMILATION
7. PROGRAM OF RECORD
8. TECHNOLOGY
9. NASA OPPORTUNITIES
10. SATM
11. SUMMARY OF FINDINGS

For PBL news send “subscribe” to: PBL-study-announcements@lists.nasa.gov
Or visit: https://lists.nasa.gov/mailman/listinfo/pbl-study-announcements

PBL Community Workshop – May 2020

Day	Topics	Virtual Attendee Count	Invited Speakers	Single Slide Community Perspectives
Tues, May 19 0800-1230 PDT	• NASA HQ Welcome and Study Team Leads Introduction • High-latitude PBL • PBL and Deep Convection	209	9 (incl. Team Leads & HQ)	3
Wed, May 20 0800-1220 PDT	• PBL over Land and Surface Interaction • PBL over the Ocean and Air-Sea Interaction	201	8	9
Tues, May 26 0800-1215 PDT	• Plenary: A Global Overview of PBL • PBL Applications • Weather and Climate Models and Data-Assimilation	204	6	8
Wed, May 27 0800-1245 PDT	• PBL passive remote sensing • PBL active remote sensing • In-situ and sub-orbital opportunities and synergies	182	7	27
			30	47

18 Hours | **11 Sessions** | **77 Presentations**

PBL Augmentation Activities – FY20

Ceilometer Data Analysis, PI Milt Halem, Belay Demoz (UMBC)

- PBL height estimates using near realtime data from ceilometer network

ICESAT-2 algorithms for PBL products, PI: Steve Palm (GSFC)

- Daytime noise reduction techniques and machine learning for PBL height estimates from ICESAT-2 data

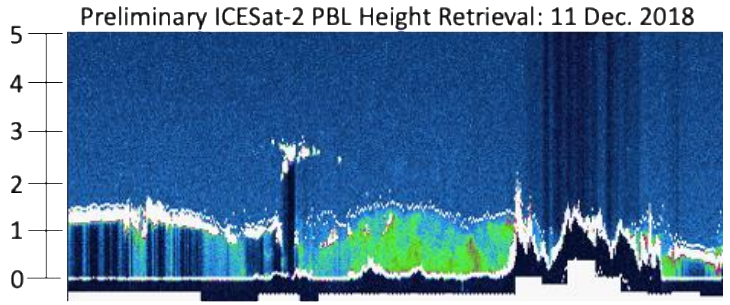
Atmospheric Boundary Layer Lidar Pathfinder (ABLE), PI: Amin Nehrir (LaRC)

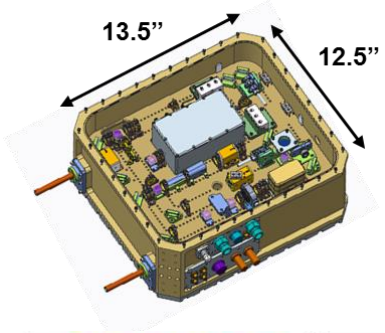
- Scale average power of HALO airborne water vapor DIAL laser to enable a future SmallSat DIAL PBL mission. Incorporate upgrades into HALO for improved observations of PBL heights, water vapor and aerosol/cloud profiles within PBL

Vapor In-Cloud Profiling Radar (VIPR), PI: Matthew Lebsock (JPL)

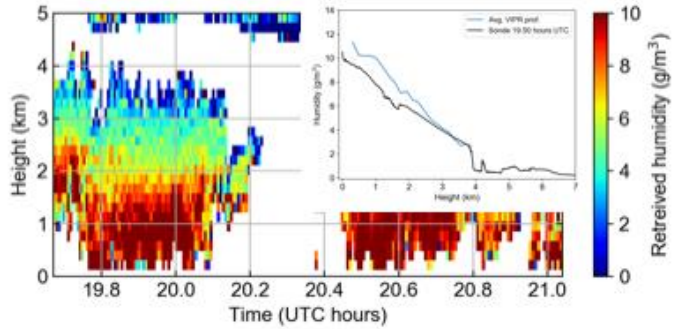
- Characterization of radome engineering models to transition VIPR to pressurized aircraft. Field testing and data-analysis to confirm utility of an additional transmit frequency to mitigate intermittent measurement biases

FY21 Augmentation Plans
All 1yr projects proposed to be continued for a second year





ABLE/HALO Water Vapor DIAL Transmitter



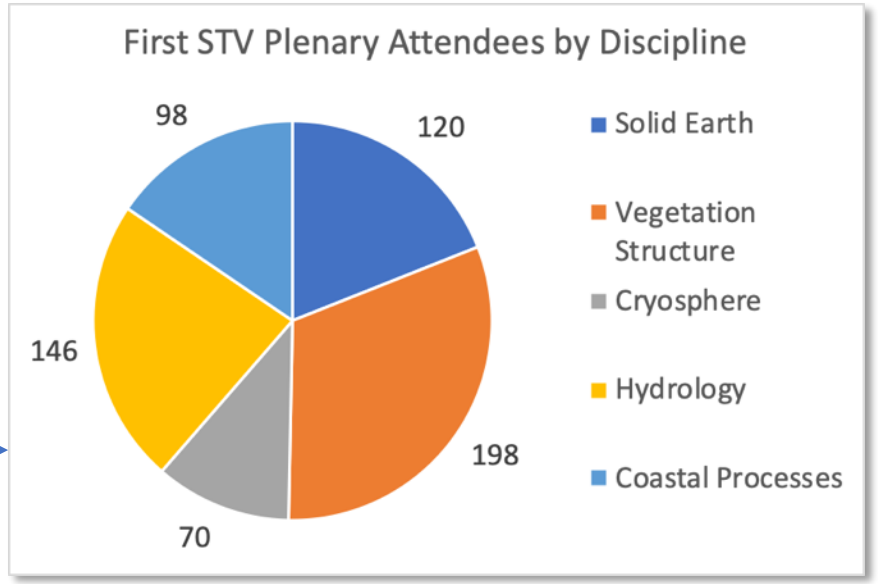
Example of occasional biases in the existing 2 wavelength VIPR system

STV Study Update

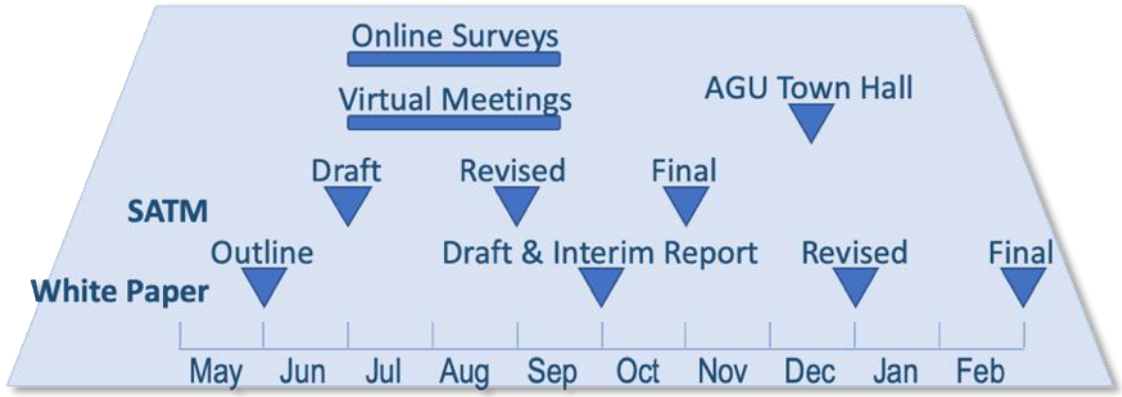
- Weekly two-hour virtual team meetings since March 2020
- Identified science, applications, and technology subgroups
  - **Science:** Solid Earth, Vegetation, Cryosphere, Hydrology, Shallow Water Bathymetry, Applications
  - **Technology:** Lidar, Stereo Photogrammetry, Radar
- Reviewed mapping of STV across the Decadal Survey
- Outlined SATM and outlining white paper structure
- Jul. 9, 2020, First Plenary STV Workshop
- STV Science Breakouts meeting schedule
  - **Vegetation Structure** Monday Jul. 13, 2020
  - **Solid Earth** Tuesday Jul. 14, 2020
  - **Cryosphere** Tuesday Jul. 21, 2020
  - **Hydrology** Monday Jul. 27, 2020
  - **Coastal Processes** Tuesday Jul. 28, 2020

  Time for all breakouts: 8 am – 12 pm PT/11 am – 3 pm ET

July 9 Workshop with 300 Total Attendees



STV Study Schedule



Get involved in the STV Study

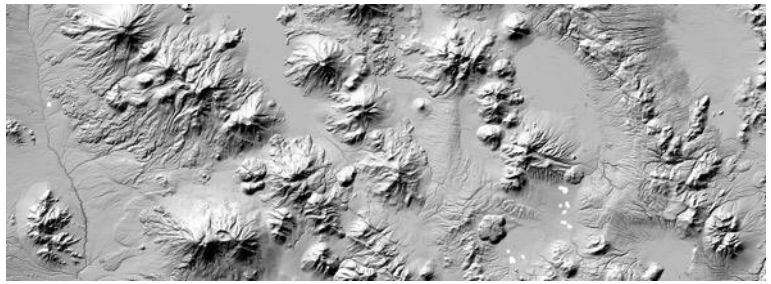
Science and Applications		Physical Parameters		Parameter Requirements**									Temporal Requirements**			
				Absolute Accuracy				Relative Accuracy		Slope Accuracy		Required Ancillary Data				
				orizontal		Vertical		Horizontal	Vertical							
Goals	Objectives	Targeted Observable(s)	Derived Parameter(s) Required		95% Confidence	Bias	95% Confidence	95% Confidence	95% Confidence	Amplitude	Azimuth		Extent Observed	Latency	Repeat Frequency	Repeat Duration
High Level	Distinguishing static measurements and temporal changes	Topography Vegetation Structure Bathymetry	Bare Earth Topography; Highest Surface Elevation; Canopy Height; 3D Canopy Structure; Above Ground Biomass; Water Surface Elevation; Water-body Bottom Topography; ation Height; Snow Depth; alent (SWE); Sea Ice Freeboard; r (specify)													

Current Technology Solutions		Identified Gaps***		Recommended Activities to Close Gaps***				
Applicable Measurement Type(s)	Are requirements currently met? Y/N	Scientific Knowledge	Technology Capabilities	Simulations	Experiments	Existing Data Analysis	Instrument Development	Platform Development

Subscribe to the STV community e-mail list:
Send e-mail to sympa@list.jpl.nasa.gov with subject *subscribe stv-community*

Follow the study online:
https://science.nasa.gov/earth-science/decadal-stv

STV Augmentation Projects



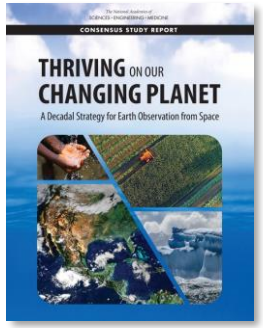
2x2 m EarthDEM example, Altiplano, Bolivia

- G-LiHT Upgrade, PI: Bruce Cook (GSFC)
  - Initiated purchase of a Phase One multispectral, survey-grade stereo aerial camera for integration and test with G-LiHT airborne imaging system
- Advanced Optical DEMS, PI: Jim Tucker (GSFC)
  - Significant progress on EarthDEM stereo processing of coastlines, faults, and volcanoes, most with multiple passes
  - Working with NSF, NGA, and NASA Data Systems Program to secure free and open release
- ICESat-2-GEDI Fusion, PI: Scott Luthcke (GSFC)
  - Significant progress on mathematical algorithm and software framework for bald Earth and vegetation canopy height fusion products
  - Initial modification to Science Data Processing System for GEDI data support complete
  - Initial database of ICESat-2 and GEDI relevant Level-1 and -2 data products constructed and tested
- UAVSAR Imager, PI: Andrea Donnellan (JPL)
  - Progress optimizing cameras and flight sensor software for Quantifying Uncertainty Kinematics of Earth Systems Imager (QUAKES-I)
  - Completed QUAKES-I CDR on June 30, 2020

FY21 Augmentations Plans:
All 1yr projects proposed to continue for a second year

QUAKES-I Nadir Imager

Cross-Benefits of Applications and Research



Amplify the Cross-Benefit of Applications and Research

	ELEMENTS OF DECADAL STRATEGY
I.	Embrace **Innovative Methodologies** for Integrated Science/Applications
II.	Commit to **Sustained Science and Applications**
III.	Amplify the **Cross-Benefit of Science and Applications**
IV.	Leverage **External Resources and Partnerships**
V.	Institutionalize **Programmatic Agility and Balance**
VI.	Exploit **External Trends** in Technology and User Needs
VII.	Expand Use of **Competition**
VIII.	Pursue **Ambitious Science**, Despite Constraints

Highlights from the Decadal Survey include:

- Inspiration goes both ways: science inspires applications scientists and engineers, and end-use needs can inspire research scientists and engineers.
- Embedding science in the applications process often reveals new and inspirational scientific questions driven by those end-uses not well-recognized by research scientists.
- … programs with both science and applications elements need to explicitly identify the connection, and define opportunities to amplify the cross-benefit …

"Amplify" suggests both that *more is needed* and that *more awareness is needed* for the activities and successes that do occur.

ESD & Cross-Benefit: Examples of Activities

NASA Earth Science has supported activities in research, applied research, and applications for years (not in equal proportions).

Examples of activities include:

- Co-Managed Initiatives
- Designed Funding Transitions
- Joint Team Meetings and Solicitations
- Applied Sciences Teams
- Integrated Science Teams
- Integrated Directed Work
- Earth Science Trainings
- Assessment Participation
- Field Campaigns

CyAN App: Cyanobacteria

The 2019 release of the CyAN mobile app to identify cyanobacteria blooms stemmed from an ESD-wide NASA project with EPA, NOAA, and USGS.

For ESD, R&A funded the initial research part, and then Applied Sciences funded the app development and transition.

CyAN App Link

NASA story

ESD & Cross-Benefit: Opportunities

[Programs] with both science and applications elements need to explicitly identify the connection, and define opportunities to amplify the cross-benefit …

Decadal Survey, p. 61

Build on current connections across R&A and Applied Sciences.

Look at activities in areas of significant potential for cross-benefit.

Priority opportunities to amplify cross-benefit:

- Sea Level Rise and Coastal Resilience
- Agriculture
- Water Quality, including Harmful Algal Blooms
- Energy, including Fossil Fuel-based and Renewables
- Air Quality

Cross-Benefit of Applications and Research

Topic	Research	Applications	Cross-Benefit	Decadal Survey
SLR and Coastal Resilience	Sea Level Change team and portal; OSST; Oceans, Land Hydrology, Ice, Solid Earth	Disasters program; Flooding and coastal zone hazards common disasters; SLR creates multiple cascading events. Local-to-regional engagements.	Tools to support users' analyses, predictions, and action to improve resilience. Local scale data to support global/regional models. RISE sea level guidance system. Delivery of sea level change forecasts to end-users.	SATM: C-8i, C-1d, C-1a, H-1b, H-4b. Data: POR, SBG, A-CCP, SDC, MC, Explorers.
Agriculture	AgMIP, Agriculture Model Intercomparison Project – global-regional long-term integrated modeling and climate impacts.	NASA Harvest with domestic companies, humanitarian uses, international trade; GEOGLAM.	Use Harvest's agility for rapid app of research. Connecting carbon and water cycle with agriculture productivity. Users identify research questions and feedback on data.	SATM: H-2c, W-5a, W-6a, S-7a. Data: POR, SBG, A-CCP, SDC, MC, Explorers.
Water Quality	Routine RSWG ROSES calls; CyAN with AppSci; Demo. of capability for coasts, inland water with airborne and sat. instruments.	Issue spans multiple Applied Sciences applications areas; HABs topic a cross-cutting issue. CyAN with R&A.	Field work with local/national partners and data delivery to local and national agencies. Connections to coastal zone.	SATM: H3-a, H-3b, H-2b, H-2c. Data: POR, SBG, A-CCP, Explorers.
Energy Fossil & Renewable	Airborne and satellite detection of methane, source-receptor modeling, solar incidence calculations; Carbon Monitoring System; Field campaigns	POWER system serves energy sector, renewables, building design and efficiency.	Transition of methane capability to local governments, routine provision of information on renewable energy potential and fossil fuel emissions. User-requests to improve spatial & temporal res. of POWER.	SATM: W-8a, W-10a, C-7e. Data: POR, GeoCarb, Libera, SBG, A-CCP, Explorers.
Air Quality	Tropospheric Composition program, field campaigns, networks, modeling	HAQAST teams with Tiger Team project done with state & local officials; H&AQ apps projects.	Participation in small-scale field campaigns with local and national partners. ARSET trainings as part of campaigns. HAQAST user feedback on data products & targeted apps.	SATM: W-5a, W-6a, W-7a, W-1a. Data: POR (TEMPO, MAIA), A-CCP, Explorers.

NASA Earth Science: Application Areas

Agriculture/Food Security

Health and Air Quality

Capacity Development

Disasters & Risk Reduction

Ecological Forecasting

Water Resources

NASA Earth Science: Research Focus Areas

14 programs overall

Atmospheric Composition
Tropospheric Composition, Upper Atmosphere, Atmospheric Composition Modeling and Analysis, Radiation Sciences

Carbon Cycle and Ecosystems
Terrestrial Ecology, Ocean Biology & Biogeochemistry, LCLUC, Biodiversity

Climate Variability and Change
Modeling & Analysis, Physical Oceanography, Cryospheric Science

Earth Surface and Interior

Water and Energy Cycle

Weather

Mutual Assessment of Current and Potential Levels of Collaboration Among R&A and Applied Sciences

May/June 2020: Managers in Applied Sciences and R&A evaluated current and potential levels of connections between individual programs in both areas.

- 14 R&A and 6 Applied Sciences areas = 84 possible connections
- Levels of Connection: Primary, Secondary, Minimal-to-None

Comparison of inputs from each set of managers showed similarities and differences:

- Similarities in the assessment of Minimal-to-None
- Similarities in the balance between current/potential connections
- Differences in the balance between primary and secondary connections: Applied Sciences managers saw greater balance; R&A managers saw mostly secondary

Next Steps:

- Respective managements are sharing results with teams and discussing next steps
- Focused discussions on areas of particular differences and on areas with little sense of potential connectivity will take place
- Brokered discussions to assess near- and longer-term opportunities (e.g. LCLUC/Cap. Building)

One-Time Augmentation of Efforts to Enhance Connectivity of Research and Applied Activities

- FY20 Budget appropriated additional resources to R&A.
- Supporting the Earth Decadal Survey's Cross-Benefit element, part of the funds are directed towards funding efforts at interface of research and applied sciences to enhance near-term connectivity and demonstrate its benefits
- Initial funding provided in two areas:
  - Tropospheric Composition–Air Quality
    Resources support NASA participation in planned DOE Air Quality campaign in Houston in 2021. This will allow for NASA presence with airborne and surface-based measurements.
  - NASA Sea Level Change Team
    Resources are adding local/regional applications focus to that can help scope out how to enhance connectivity in a more sustained way.
- Remaining funding is being looked at in following areas
  - Water quality
  - Agriculture/food security

ESD & Cross-Benefit: New Research Pursuits

Embedding science in the applications process often reveals new and inspirational scientific questions driven by those end-uses not well-recognized by research scientists …

Decadal Survey, p. 61

NASA Harvest is an ESD-sponsored consortium to enable uses of Earth obs. for agriculture and food security in the U.S. and globally. ‘

NASA Harvest’s engagement with users from private-, NGO-, and public sectors have identified research questions, data needs, and other challenges that all parts of ESD are suited to address.

NASA Harvest authored the GEOGLAM Community Research Agenda.

Examples:

- How do sustainable and regenerative practices affect yields, soil health, water, and biodiversity?
- What are key yield drivers under different cropping systems?
- How does ET change with crop and land cover types and management practices?
- How does sustainable production practices managing nitrogen in the soil impact water quality and crop yield?
- How will a changing climate affect irrigation needs and farm management decisions (and competition for freshwater)?

Earth Science Advisory Committees

Earth Science Advisory Committee (ESAC)

- ESD leadership discussed the Cross-benefit topic with ESAC at the March 2020 ESAC meeting.

Applied Sciences Advisory Committee (ASAC)

- Recent recommendation from ASAC:
  ASAC requests that a future meeting have a discussion with R&A to examine other parts of ESD that address applications.
- At the upcoming ASAC meeting on July 28-30, the topic of Earth science applications in ESD elements is part of the agenda. The R&A program and the Earth Science Data Systems program will speak with ASAC about applications-related topics.
- These efforts are part of efforts to amplify cross-benefit of applications and research.

Evaluation of Application-Oriented Work in R&A Program

For ASAC Discussion July 29:
R&A staff is assessing of more application-oriented work that it has been historically supporting. Prime focus is direct connection to use of results in assessments, management, policy/regulation development, and routine/operational forecasting.

Primary areas examined in this internal analysis:

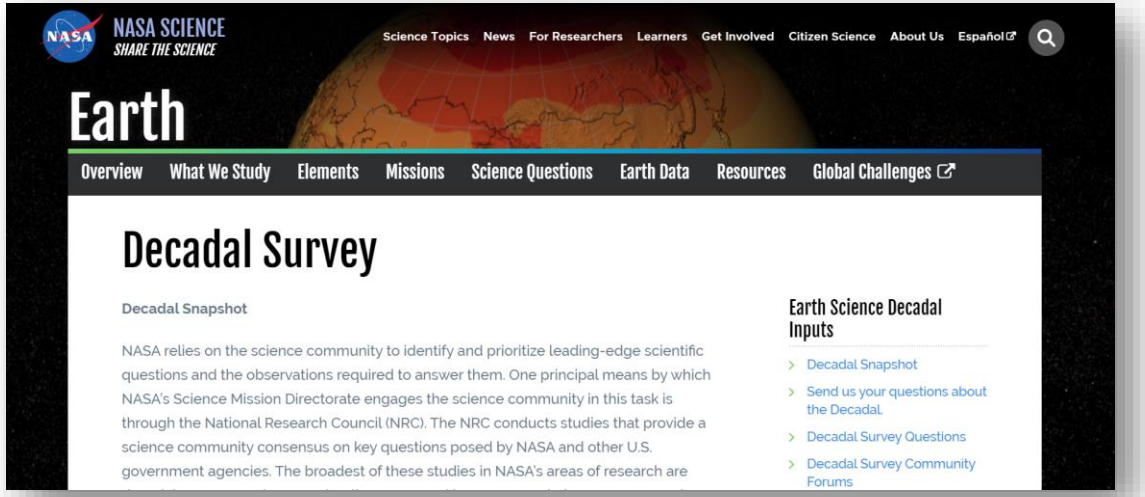
- Ozone assessment
- Chemically/radiatively active source gas measurement in support of Montreal Protocol
- Air quality related work
- Methane observations
- Water quality
- Work historically in support of National Climate Assessment
- Assimilation/forecasting in support of field missions
- Large scale agriculture (AgMIP)
- Urbanization
- Direct into organized assessments (WMO/UNEP, IPCC, IPBES, WOA, AMAP, NCA …)
- Space geodesy inputs into tracking/reference frames/etc.
- Natural hazard detection/avoidance/response
- Polar changes
- Sea level rise coastal impacts
- Severe storms
- Urban heat islands and other impacts of land cover/land use change

What’s Next?

What's Next?

ESD Decadal Survey Web Page: https://science.nasa.gov/earth-science/decadal-surveys

- ESD Leadership Team continues to address additional DS topics
- Check the ESD Decadal Survey web page to:
  - Find meeting schedules and details
  - Ask questions and see answers as they become available
  - Review information in previous sets of charts
- Community Forums
  - Next forum: **Nov. 12, 2020**; forum will be held from 1-3 p.m. (Eastern)
  - WebEx and telecon information, in addition to other updates, will be posted on the NASA ESD Decadal Survey website
  - For information about future Decadal Survey Community Forums, please send an email to Amy Treat at Amy.A.Treat@nasa.gov



Questions Process

- This call is monitored by an operator
  - When you join the call, the operator will ask for your name
- When it is time for questions, please press *1 on your phone to indicate to the operator that you have a question
- The operator will introduce you by name and un-mute your line
  - Then you can ask your question and any follow up questions
- When done, the operator will re-mute your line and introduce the next person
- Please also email questions to **Amy Treat** at **Amy.A.Treat@nasa.gov** so we can post the question and its answer on our website

How to Get Involved!

- To join a working group or sign up for updates, send an email to:
  - **SBG:** sbg@jpl.nasa.gov
  - **MC:** masschange@jpl.nasa.gov
  - **SDC:** sdc-study@lists.nasa.gov
  - **ACCP:** a-ccp-comments@lists.nasa.gov
- General updates can be found on our website: https://science.nasa.gov/earth-science/decadal-surveys/

Backup

Targeted Observables Priorities

Targeted Observable	Science/Applications Summary	Candidate Measurement Approach	Designated	Explorer	Incubation
Aerosols	Aerosol properties, aerosol vertical profiles, and cloud properties to understand their direct and indirect effects on climate and air quality	Backscatter lidar and multi-channel/multi-angle polarization imaging radiometer flown together on the same platform	X		
Clouds, Convection and Precipitation	Coupled cloud-precipitation state and dynamics for monitoring global hydrological cycle and understanding contributing processes	Radar(s), with multi-frequency passive microwave and sub-mm radiometer	X		
Mass Change	Large-scale Earth dynamics measured by the changing mass distribution within and between Earth's atmosphere, oceans, ground water, and ice sheets	Spacecraft ranging measurement of gravity anomaly	X		
Surface Biology and Geology	Earth surface geology and biology, ground/water temperature, snow reflectivity, active geological processes, vegetation traits and algal biomass	Hyperspectral imagery in the visible and shortwave infrared, multi- or hyperspectral imagery in the thermal IR	X		
Surface Deformation and Change	Earth surface dynamics from earthquakes and landslides to ice sheets and permafrost	Interferometric Synthetic Aperature Radar (InSAR) with ionospheric correction	X		
Greenhouse Gases	CO2 and methane fluxes and trends, global and regional with quantification of point sources and identification of source types	Multispectral short wave IR and thermal IR sounders; or lidar **		X	
Ice Elevation	Global ice characterization including elevation change of land ice to assess sea level contributions and freeboard height of sea ice to assess sea ice/ocean/atmosphere interaction	Lidar **		X	
Ocean Surface Winds and Currents	Coincident high-accuracy currents and vector winder to assess air-sea momentum exchange and to infer upwelling, upper ocean mixing, and sea-ice drift	Radar scatterometer		X	

*** Could potentially be addressed by a multi-function lidar designed to address two or more of the Targeted Observables*

Targeted Observables Priorities

Targeted Observable	Science/Applications Summary	Candidate Measurement Approach	Designated	Explorer	Incubation
Ozone and Trace Gases	Vertical profiles of ozone and trace gases (including water vapor, CO, NO2, methane, and N20) globally and with high spatial resolution	UV/IR/microwave limb/nadir sounding and UV/IR solar/stellar occultation		X	
Snow Depth and Snow Water Equivalent	Snow depth and snow water equivalent including high spatial resolution in mountain areas	Radar (Ka/Ku band) altimeter; or lidar**		X	
Terrestrial Ecosystem Structure	3D structure of terrestrial ecosystem including forest canopy and above ground biomass and changes in above ground carbon stock from processes such as deforestation and forest degradation	Lidar**		X	
Atmospheric Winds	3D winds in troposphere/PBL for transport of pollutants/carbon/aerosol and water vapor, wind energy, cloud dynamics and convection, and large-scale circulation	Active sensing (lidar, radar, scatterometer); passive imagery or radiometry-based atmos. motion vectors (AMVs) tracking; or lidar**		X	X
Planetary Boundary Layer	Diurnal 3D PBL thermodynamic properties and 2D PBL structure to understand the impact of PBL processes on weather and AQ through high vertical and temporal profiling of PBL temperature, moisture and heights	Microwave, hyperspectral IR sounder(s) (e.g., in geo or small sat constellation), GPS radio occultation for diurnal PBL temperature and humidity and heights; water vapor profiling and DIAL lidar; and lidar** for PBL height			X
Surface Topography and Vegetation	High-resolution global topography including bare surface land topography, ice topography, vegetation structure, and shallow water bathymetry	Radar; or lidar**			X

*** Could potentially be addressed by a multi-function lidar designed to address two or more of the Targeted Observables*

Other ESAS 2017 Targeted Observables not allocated to a Flight Program element: Aquatic Biogeochemistry, Magnetic Field Changes, Ocean Ecosystem Structure, Radiance Intercallibration, Sea Surface Salinity, Soil Moisture

See: https://science.nasa.gov/earth-science/decadal-surveys

ESD has decided to treat Atmospheric Winds as Explorer