

National Aeronautics and
Space Administration



EXPLORE EARTH

Earth Science Division

Decadal Survey Briefing with Stakeholders

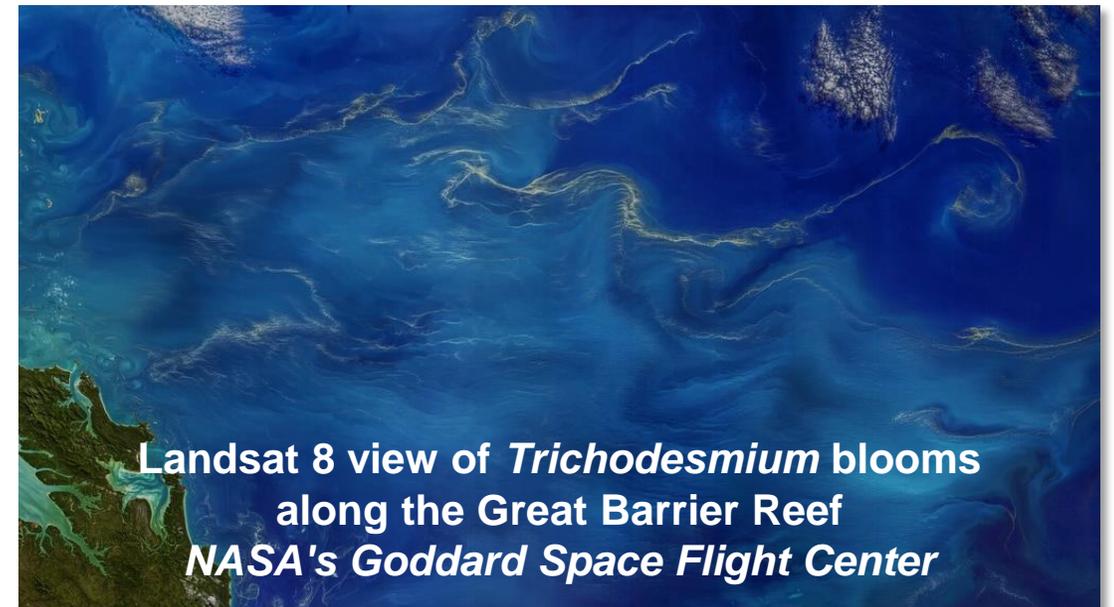
Dr. Karen St. Germain

ESD Director

April 15, 2021

Agenda

- Earth Science Division Overview
- DO Principles and Transition to Pre-Phase A
- Explorers
- Open Science
- Interactions of Applications and Research
- Incubation Program
- What's Next
- Q&A



Questions Process

- During the Q&A, please type your question directly in the Q&A panel
- Or you can email questions to Molly Olonoff at Molly.L.Olonoff@nasa.gov
- Answers to relevant questions will be posted on our website: <https://science.nasa.gov/earth-science/decadal-surveys>

The background of the slide is a composite of two cosmic images. The top half features a dark blue and black space filled with numerous small stars and a prominent, glowing blue nebula on the right side. The bottom half features a gradient from orange to green, with a large, bright green nebula on the right and many smaller stars scattered throughout.

Earth Science Division Overview

Justice, Equity, Diversity, and Inclusion (JEDI) Group

GOAL: To build a diverse, equitable, inclusive, accessible, and just environment for marginalized communities within the Earth science community by identifying, proposing, and implementing anti-racist actions



Guiding principles:

- Improve IDEA and environmental Justice for Black, Indigenous, and People of Color (BIPOC) communities within the Earth science community
- Actions can be directly undertaken within and specifically benefit ESD's community
- Enabled and championed by ESD Leadership's vision, support, and advocacy
- Create a learning environment around the issues of Justice, Equity, Inclusion, and Diversity
- Modify the criteria, processes, practices, and structures we have in place for soliciting and evaluating proposals to make them more inclusive and equitable, and
- Work together with a diverse outside community to remove barriers for underrepresented groups to participate in and benefit from EO data and application uses

ESD's JEDI Commitment to Inclusion



Prioritize and focus on increasing engagement with minority-serving institutions, HBCUs, and other under-represented groups



Piloted Speak Up! internal educational email series to promote more inclusive language in the workplace



Mandatory training and community dialogues, and workshops to provide necessary trainings on systemic racism and injustices



Continue to collect and analyze current demographic data across programs funding areas



Piloted Dual Anonymous Peer Review across NASA Science through ROSES-2020

- 2021 Cryospheric Science calls



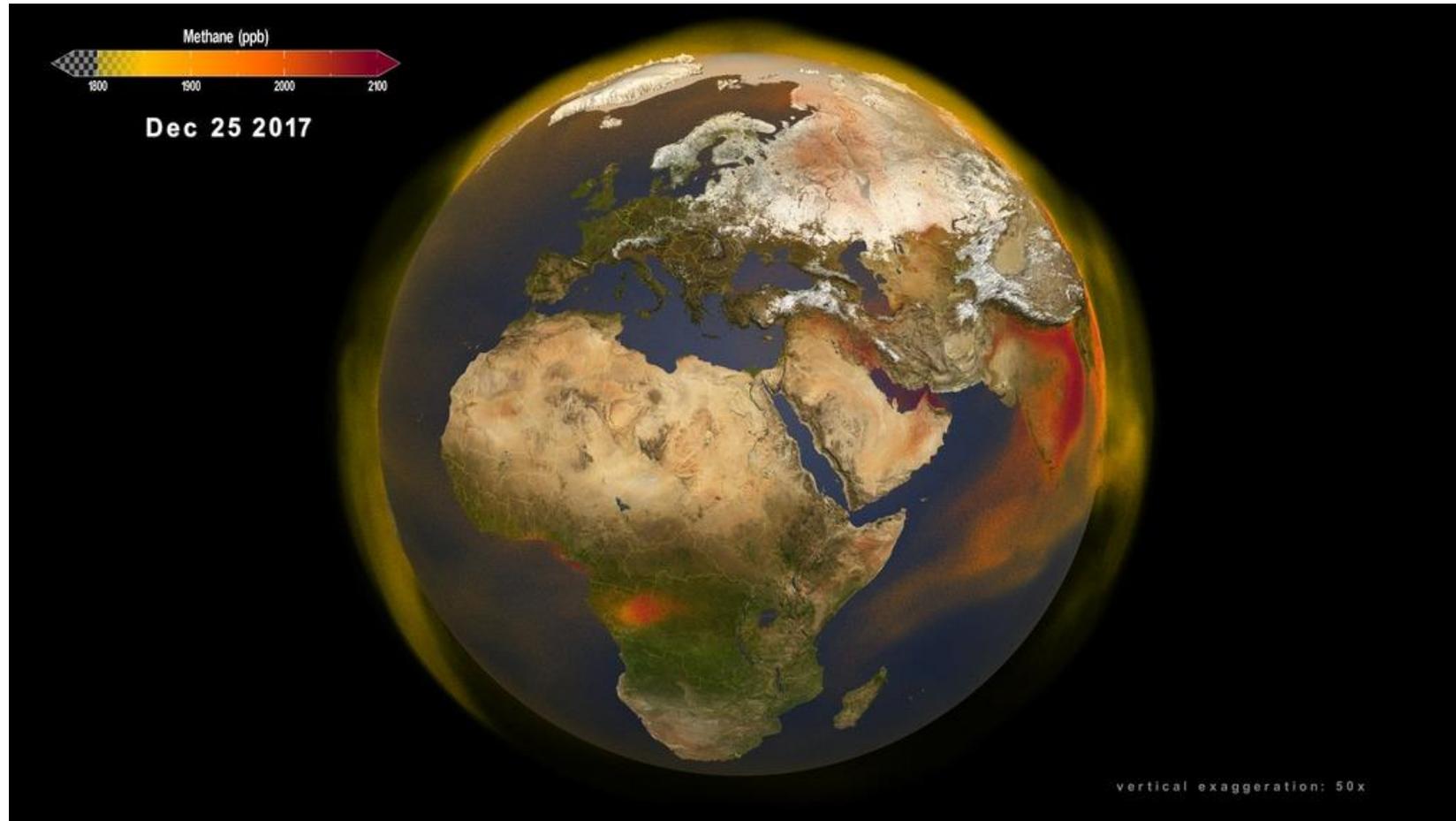
Advancing Diversity of Review Panels and Reviewing NASA Science R&A Code of Conduct



Increasing Participation in Earth Science Surface Based Measurement Networks RFI

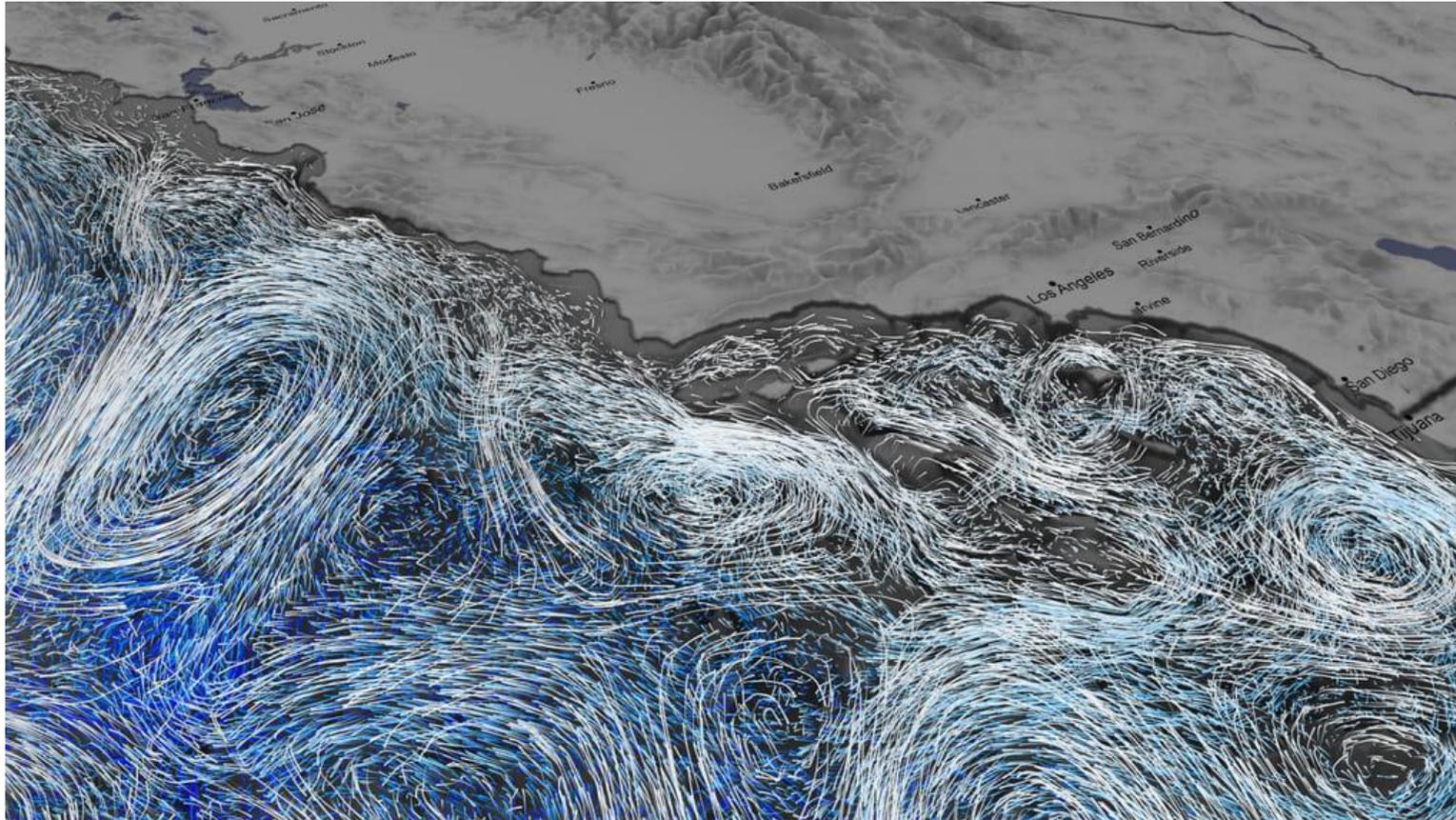
Executive Order on Tackling the Climate Crisis at Home and Abroad

"Together, we must listen to science and meet the moment."



Global atmospheric methane on December 25, 2017. *NASA's Scientific Visualization Studio.*

White House National Climate Task Force



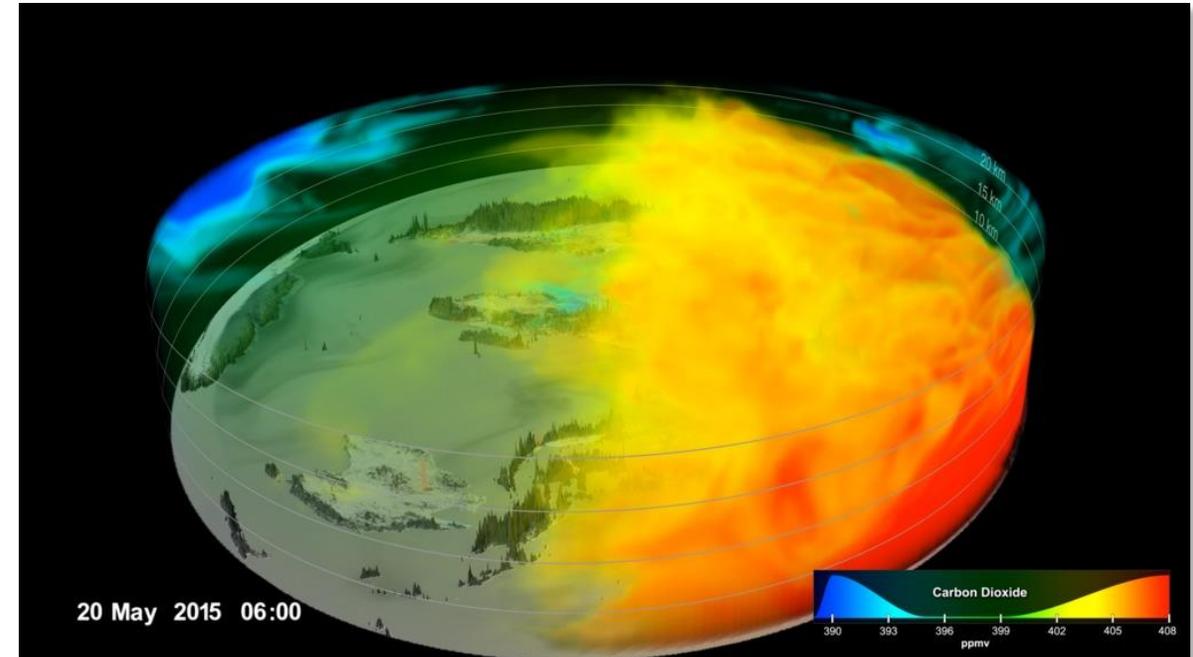
Through its long-term observations of Earth, providing insight into how the planet is changing, efforts to contribute to sustainable aviation and nurturing partnerships with the private sector, **NASA is poised to help the task force address the most pressing climate change issues today.**

Ocean flows off the west coast of the United States, created in support of NASA's 2020 Sea Level Rise campaign. *NASA's Scientific Visualization Studio.*

Supporting U.S. Actions Related to Rejoining the Paris Climate Agreement

Leadership in the required Global Stocktake

- NASA, JAXA, ESA unique satellite-based GHG observations
- Other satellite assets (operational/research) for ocean/land biomass
- NOAA and international in situ (ground, aircraft) observations
- NOAA/OAR CarbonTracker (modeling) for data assimilation
- NASA-related modeling research
- Collaboration with Copernicus services
- Active engagement with WMO IG3IS activity and related international coordination

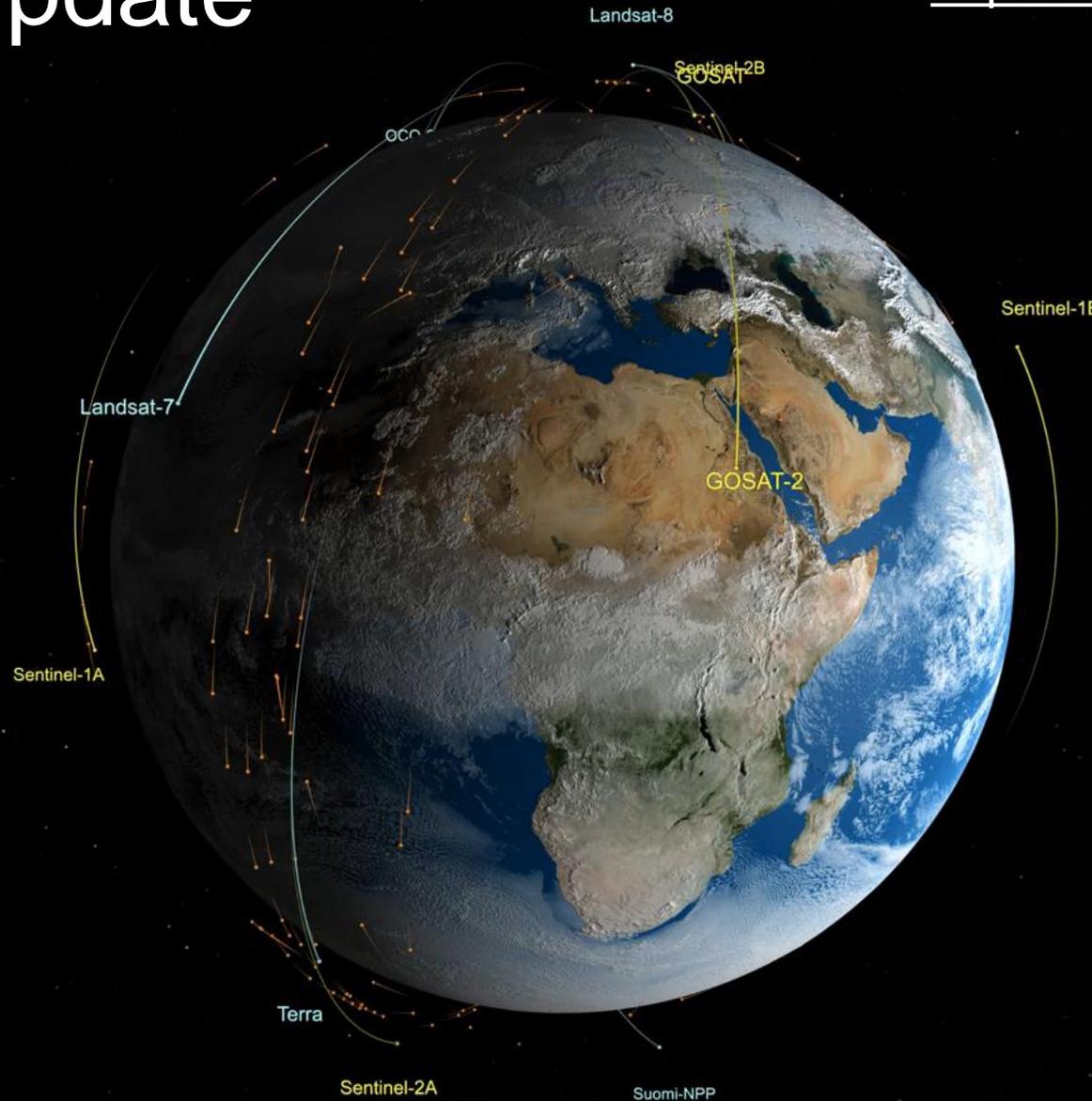


3-D view of Earth's carbon dioxide. In the Northern Hemisphere (right) carbon dioxide accumulates in the winter and spring when plants are dormant.
NASA's Scientific Visualization Studio.

COVID-19 Update

<https://earthdata.nasa.gov/covid19/>

<https://eodashboard.org/>



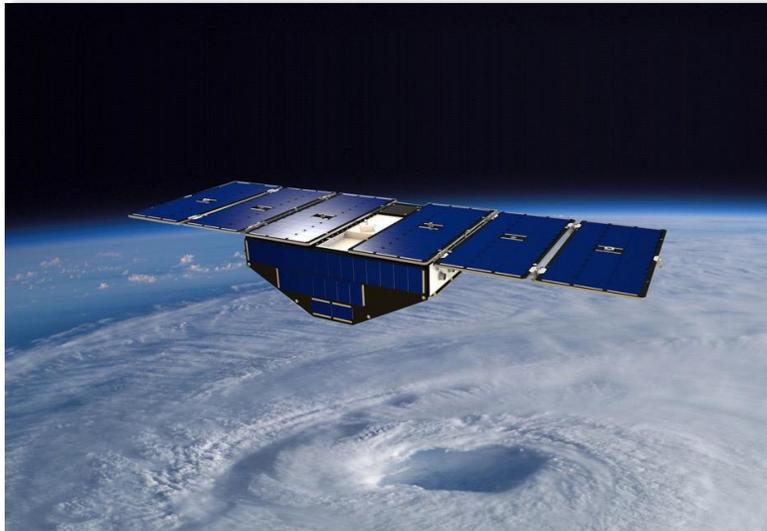
COVID-19 Earth Observing Fleet

NASA's Scientific Visualization Studio

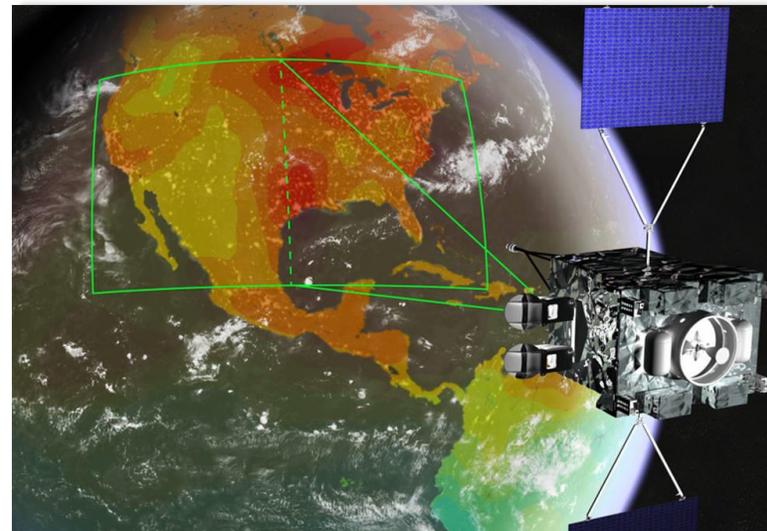
USA
International
Commercial

EVM-3 Announcement of Opportunity (AO)

Released November 18, 2020; Proposals were due March 25, 2021



EVM-1 (CYGNSS)



EVM-2 (GeoCarb)

EVM-3
& NOAA
Operational Enhancement
Opportunity

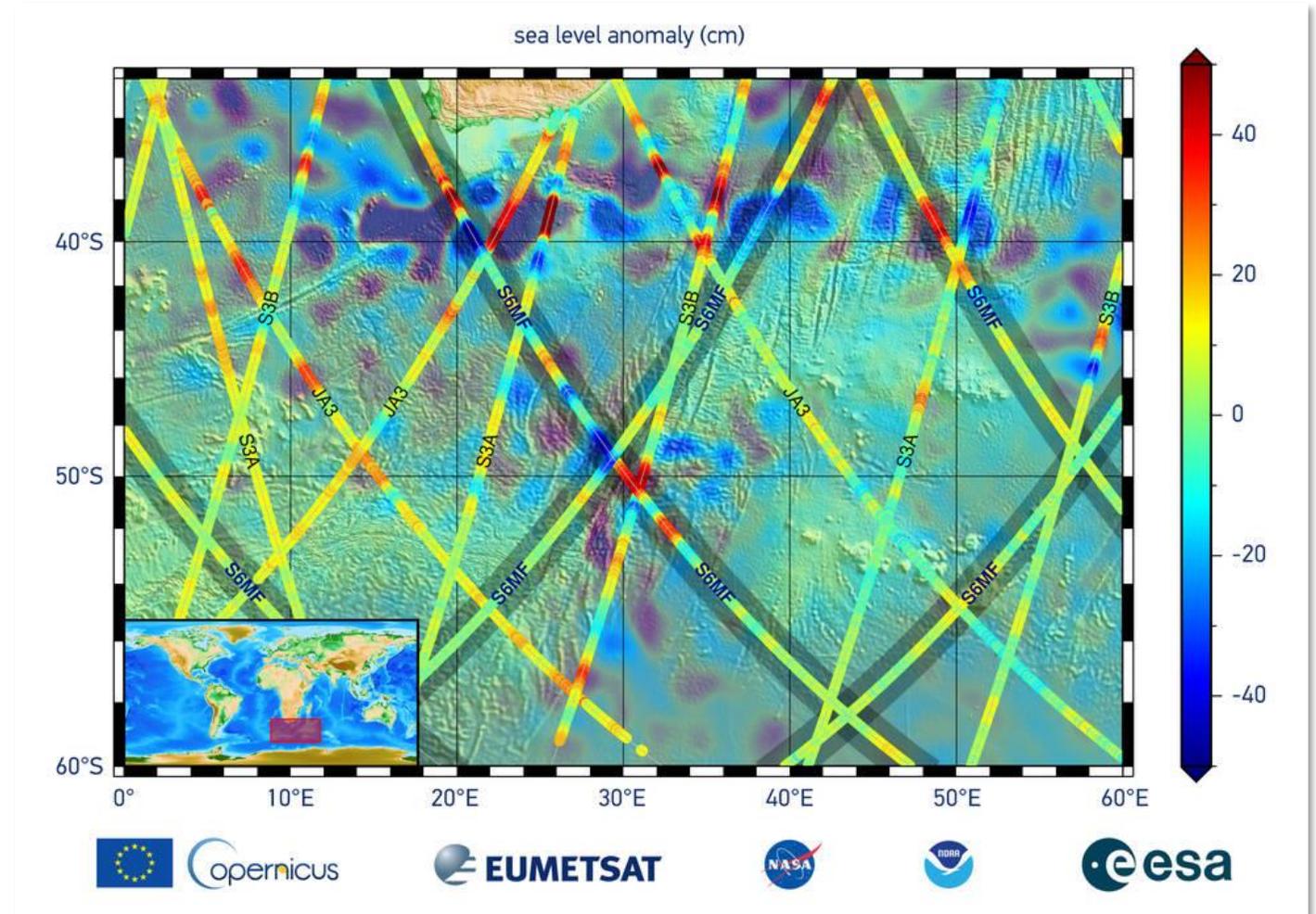
NASA EARTH FLEET

OPERATING & FUTURE THROUGH 2023



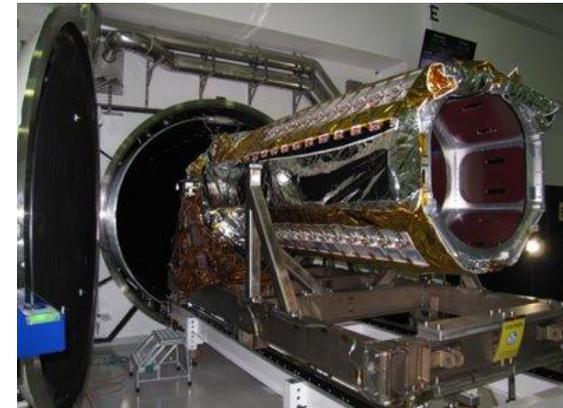
Sentinel-6 Michael Freilich

- Successfully passed Post Launch Assessment Review (PLAR) on February 25, 2021.
- Now, the team is going through the cal/val process and data will be available to the public in summer 2021
- The data in the **graphic on the right** are the first sea surface height measurements from the Sentinel-6 Michael Freilich satellite, which launched November 21, 2020. They show the ocean off the southern tip of Africa, with red colors indicating higher sea level relative to blue areas, which are lower.



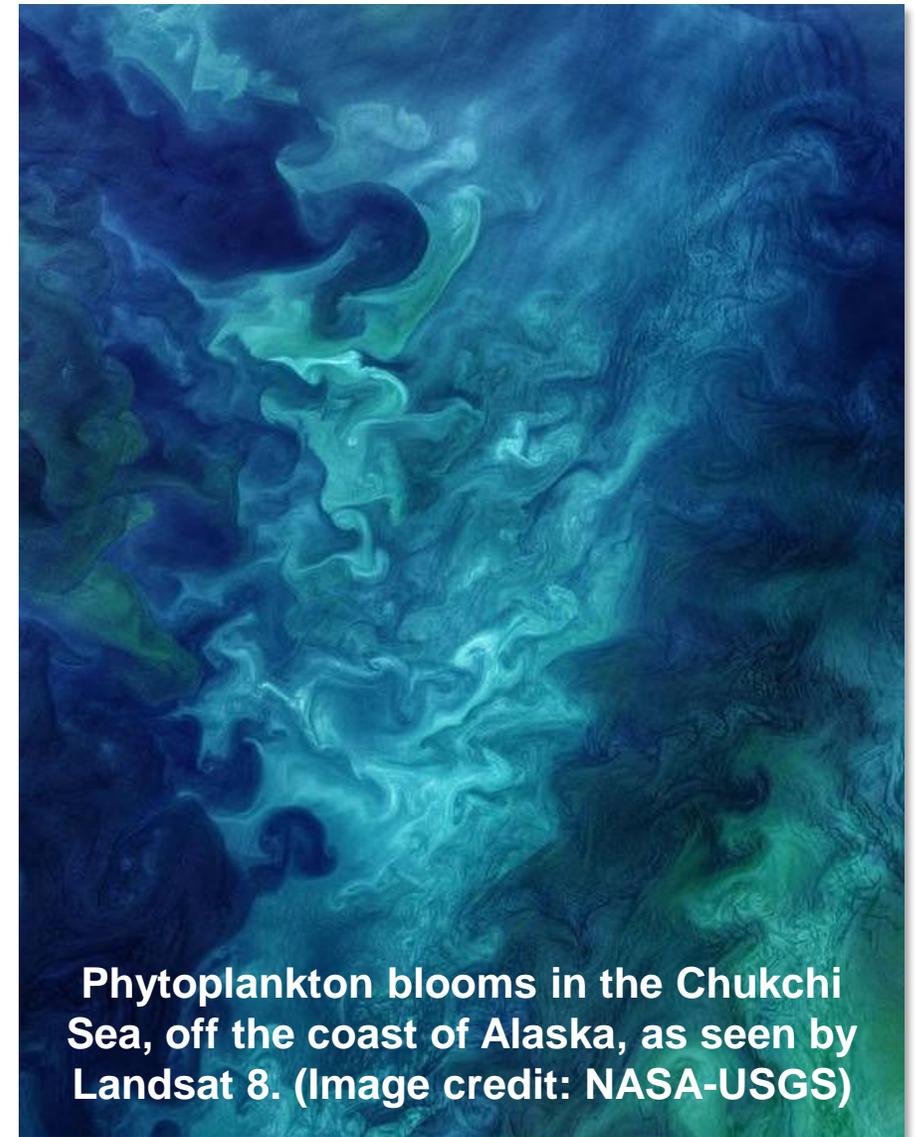
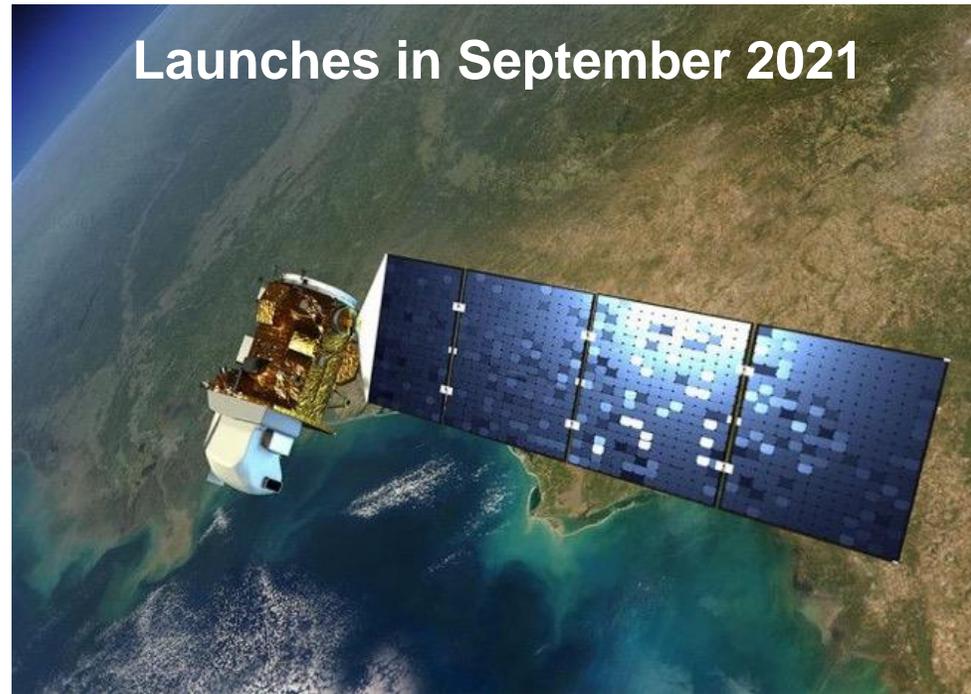
NISAR Key Achievement

- The S-band SAR, one of two kinds of radar on the NISAR mission, arrived at JPL on March 19.
- The next day, technicians and engineers moved the S-SAR into the airlock to the Spacecraft Assembly Facility's High Bay 1 clean room.
- The equipment was unpacked over several days in the clean room.



Next Launch: Landsat 9

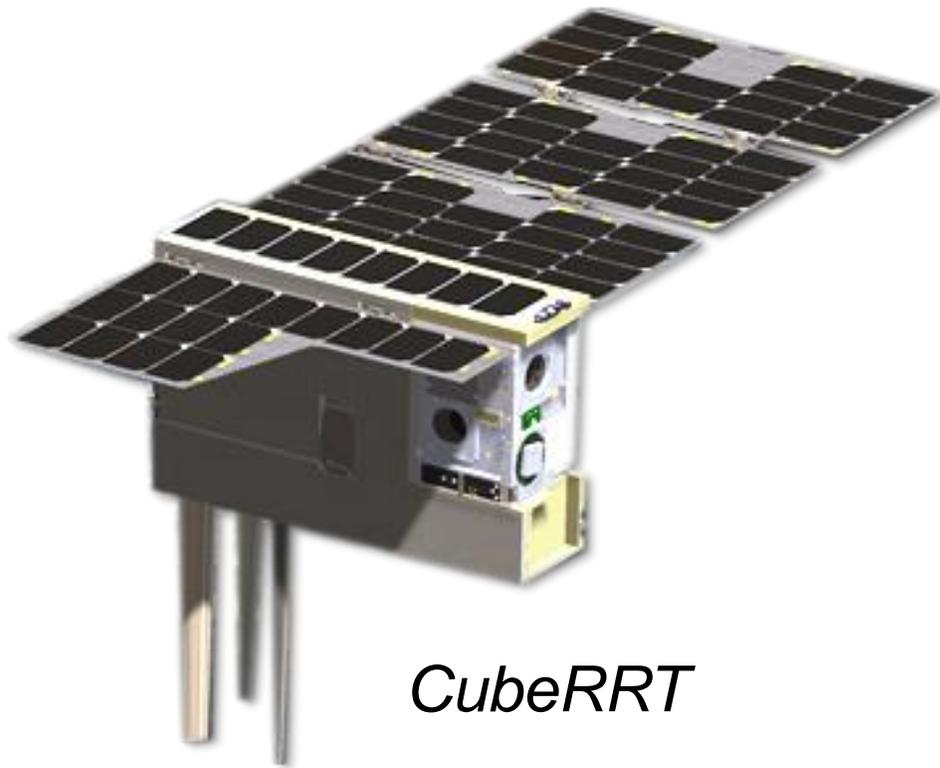
- Designed and operated to repeatedly observe the global land surface at a moderate scale that shows both natural and human-induced change
- USGS Partnership



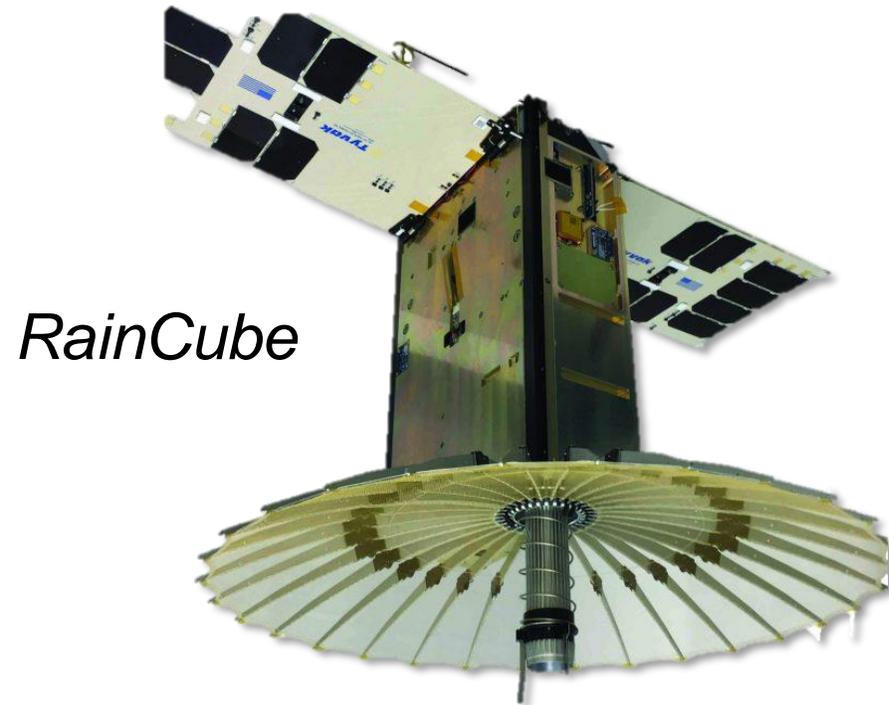
Phytoplankton blooms in the Chukchi Sea, off the coast of Alaska, as seen by Landsat 8. (Image credit: NASA-USGS)

2020 Holidays Mark End for Two CubeSat Missions

- Thanksgiving 2020 – CubeRRT (CubeSat Radio Frequency Interference Radiometer Technology)
- Christmas 2020 – RainCube (Radar in a CubeSat)

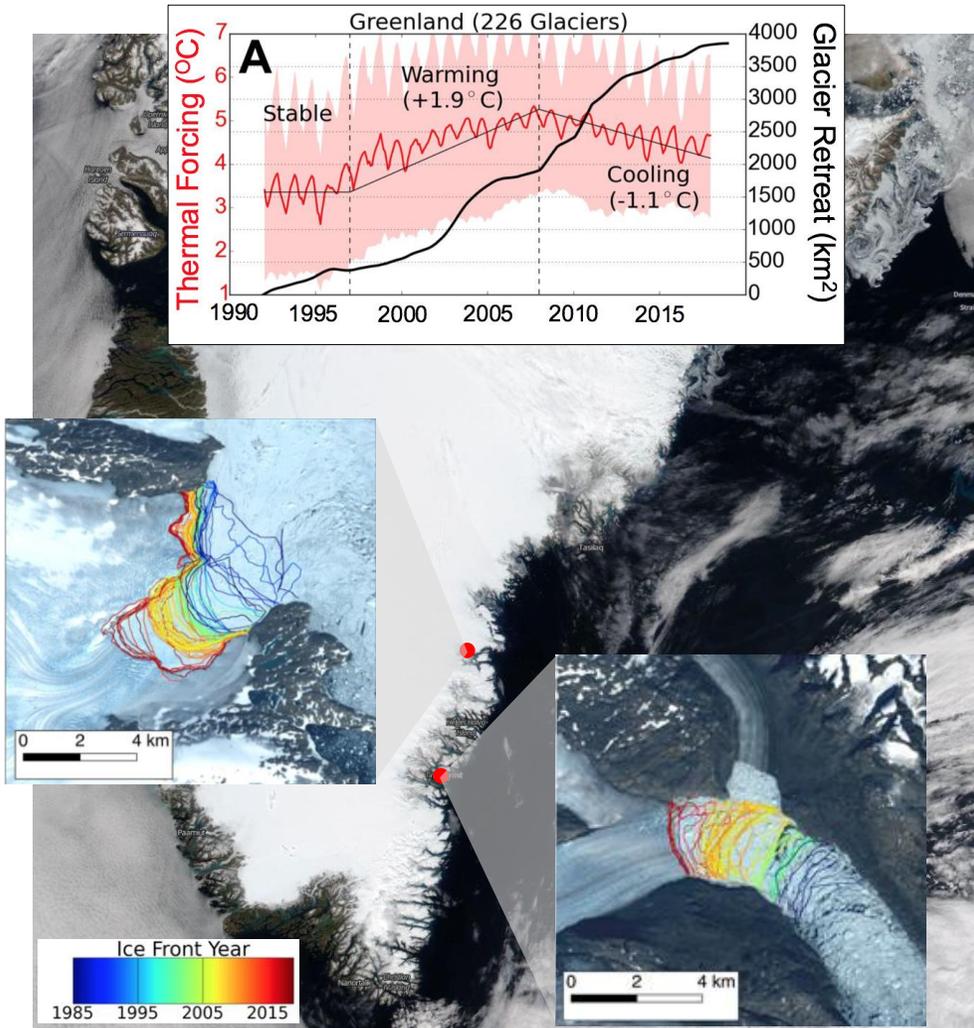


CubeRRT



RainCube

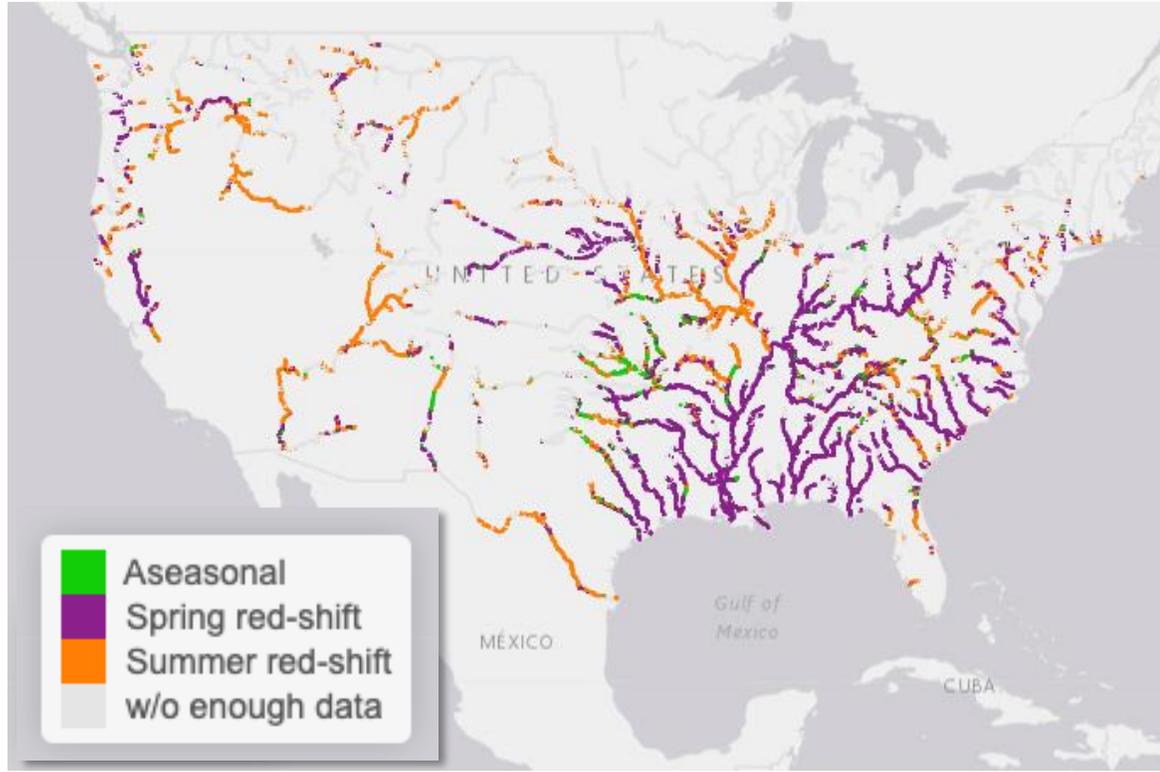
OMG: Ocean Warming Drives Greenland Glacier Retreat



- Multi-year measurements from Oceans Melting Greenland (OMG)
- Role of ocean warming in ice sheet dynamics below the surface
 - Warming indicated by average ocean temperature below 200m
- Ice sheet loss linked from “undercutting”
 - Warm, salty water at bottom of fjords melts the base of a glacier, causing ice above to break apart
 - Changes loss estimates by at least a factor of 2
 - Most significant in deep fjords
- “Memory” in the system
 - Ocean warming paused in 2008–2017, but the net ice discharge from Greenland glaciers kept increasing, ice fronts kept retreating, and rate of undercutting remained higher than in the previous decade

Wood, M., et al. (2021). Ocean forcing drives glacier retreat in Greenland. *Science Advances*, 7(1), <https://doi.org/10.1126/sciadv.aba7282>

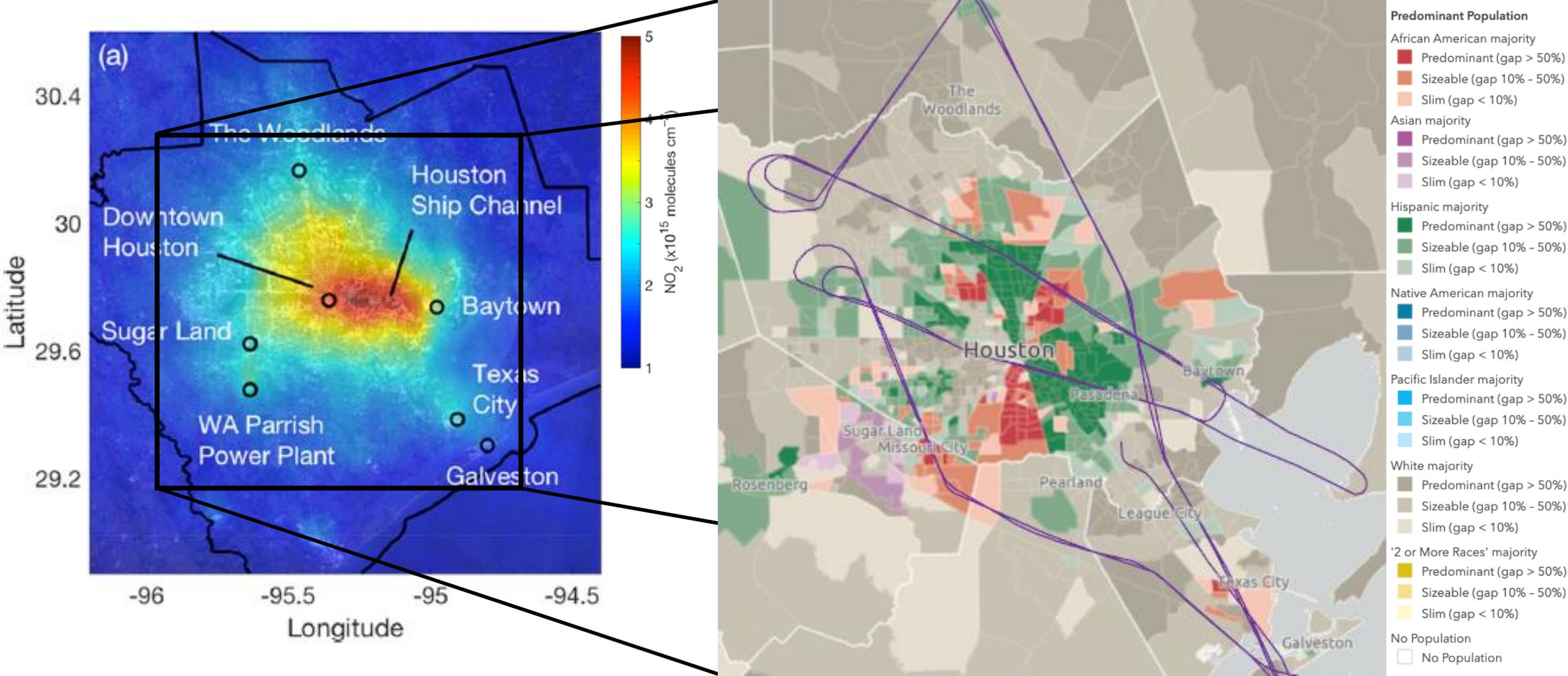
Color of U.S. Rivers is Changing



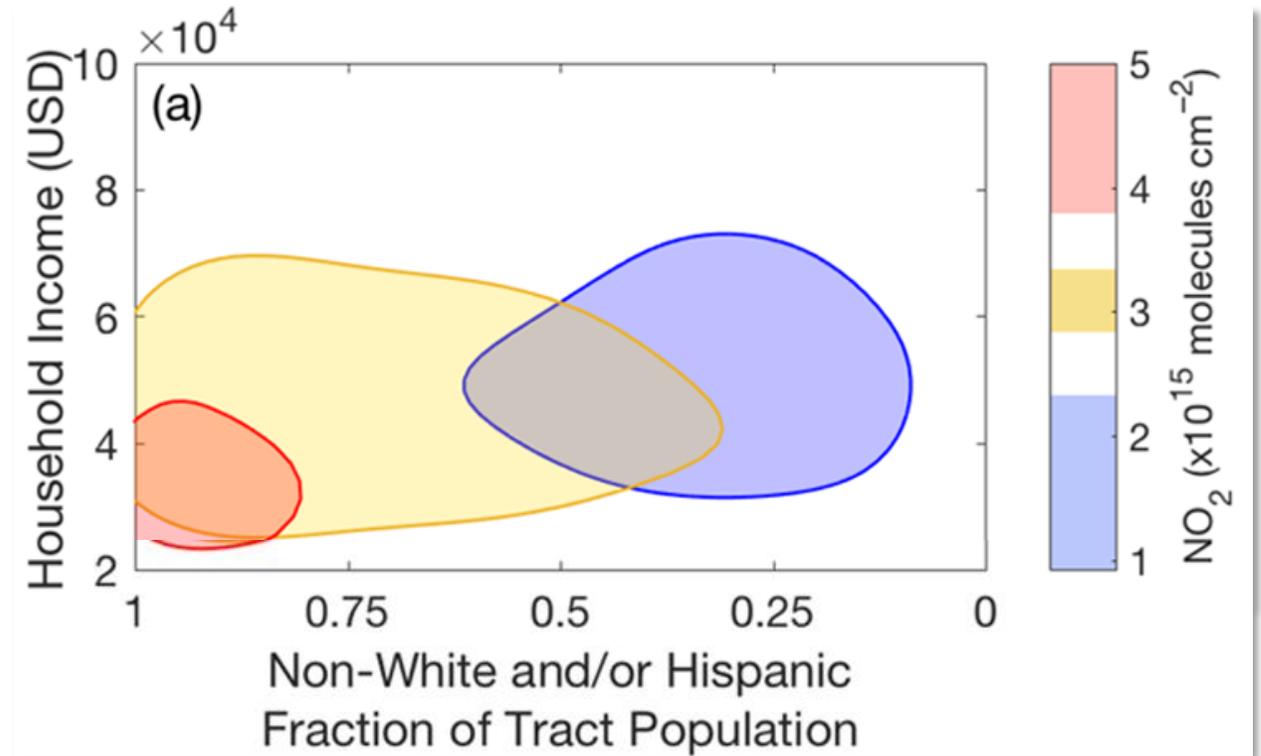
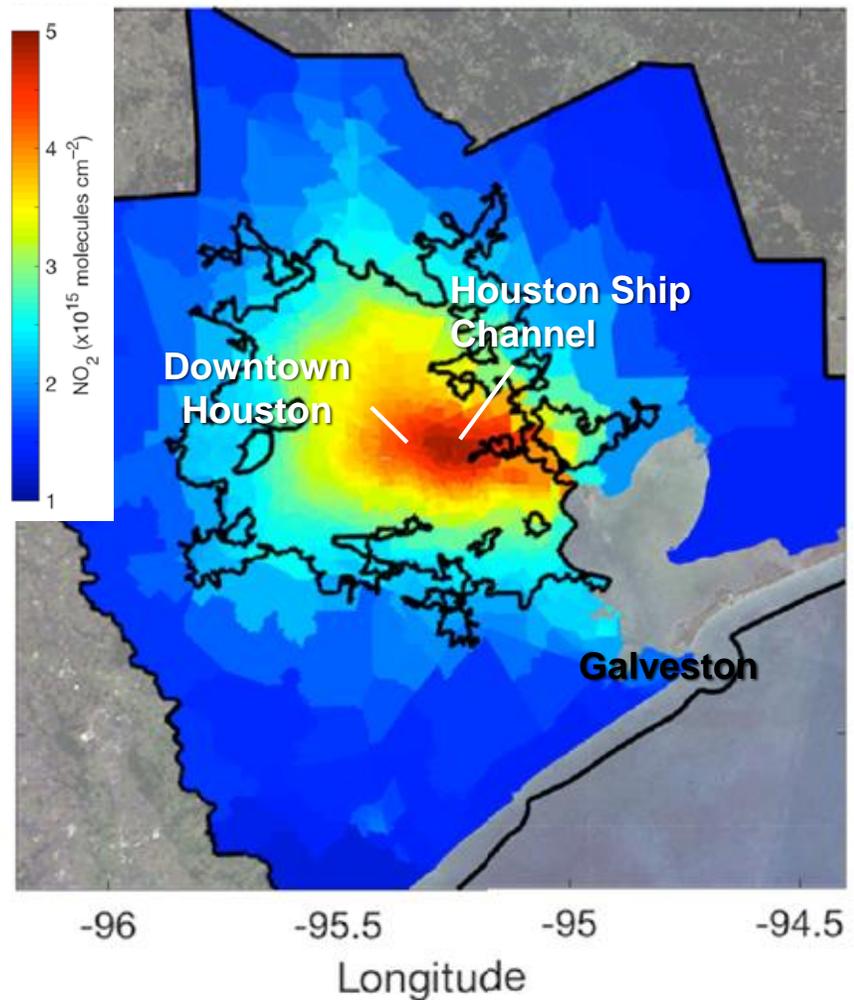
Gardner, J. R., Yang, X., Topp*, S. N., Ross, M. R. V., Altenau, E. H., & Pavelsky, T. M. (2021). The color of rivers. *GRL*, 48(1), <https://doi.org/10.1029/2020GL088946>

- First map of U.S. river color from river surface reflectance between 1984-2018 from Landsat imagery
- Colors such as blues, greens, browns, and yellows, linked to water quality
 - Related to the amount of sediment, algae, and dissolved organic carbon in water
 - Three seasonal patterns identified
- River color can indicate rivers and drain basin land-areas are undergoing rapid environmental change
 - River flow
 - Land use
 - Watershed management
- **One third** of U.S. rivers had significant color shifts over the last 35 years
 - Hotspots often located near dams and urban areas

Pollution Disproportionately Impacts Low-Income, Non-White, and Hispanic Neighborhoods in Houston, TX



Pollution Disproportionately Impacts Low-Income, Non-White, and Hispanic Neighborhoods in Houston, TX



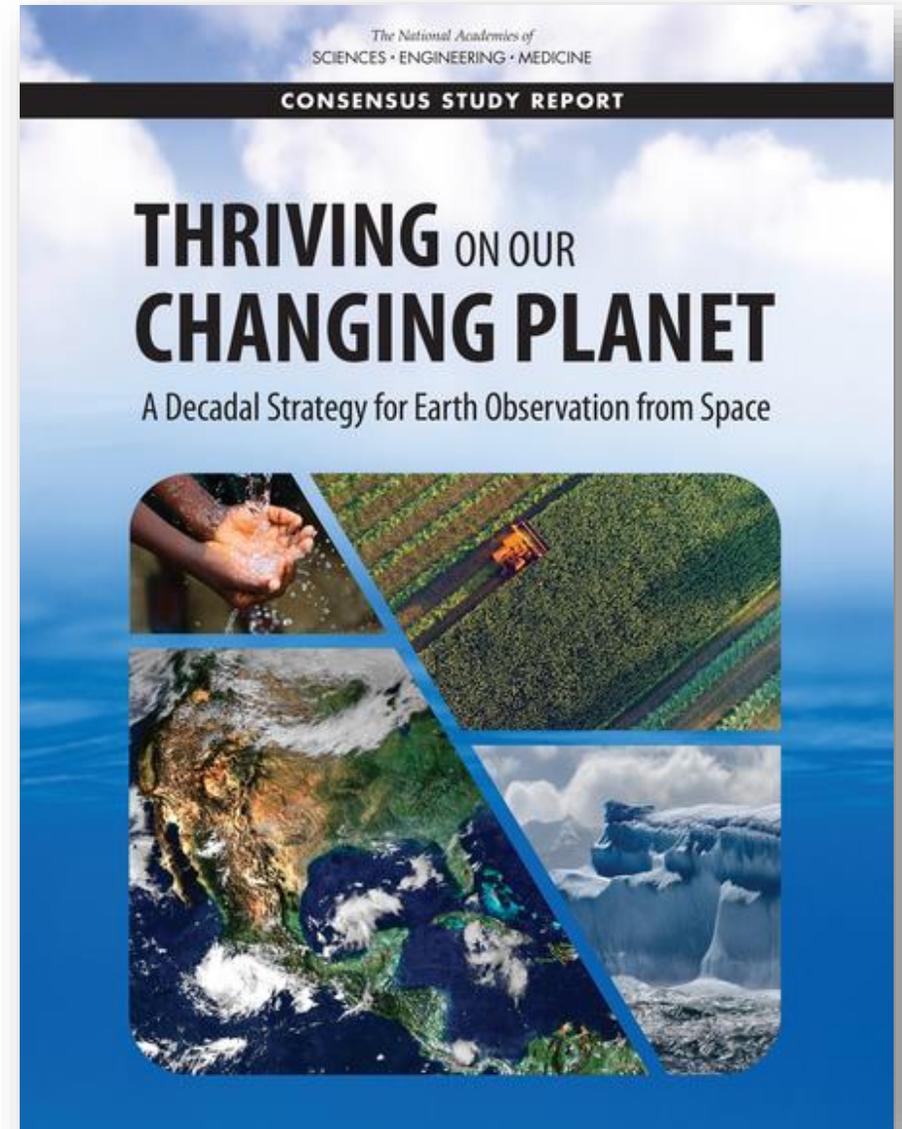
Demetillo**, M. A. G., Navarro, A., Knowles, K. K., Fields, K. P., Geddes, J. A., et al (2020). Observing nitrogen dioxide air pollution inequality using high-spatial-resolution remote sensing measurements in Houston, Texas. *Environmental Science & Technology*, 54(16), 9882–9895. <https://doi.org/10.1021/acs.est.0c01864> **FINESST proposal



DO Principles and Transition to Pre-Phase A

2017 Decadal Survey

- Emphasizes partnerships and innovation
- Identifies key questions and observations for:
 - Climate variability and change
 - Weather and air quality
 - Hydrological cycles and water resources
 - Ecosystems and natural resource management
 - Solid Earth dynamics and hazards
- Five *Designated Observables*:
 - Aerosols (A)*
 - Clouds, Convection & Precipitation (CCP)*
 - Mass Change (MC)*
 - Surface Biology & Geology (SBG)
 - Surface Deformation & Change (SDC)*
- Competed *Earth System Explorers*, an *Incubation* element, and *Earth Venture Continuity*



* Indicates observable addresses **Most Important** Climate Variability & Change Questions

NASA Principles to Initiate Decadal Observables Programs

- Accomplish Decadal objectives, within constraints
- Be intentional about NASA strategic leadership
- Pursue strategic international partnerships
- Incorporate speed and innovation across the entire value chain
- Leverage U.S. space industry and commercial capabilities
- Establish reserves, within cost targets, consistent with risk posture and prior experience



Ice of various shapes and thicknesses hugs the Labrador Peninsula's coast. *NASA Earth Observatory.*

Initial ESD Strategy

- **Close out** five 2007 Decadal Survey studies
 - ACE, ASCENDS, CLARREO, GEO-CAPE, HypsIRI
- Prioritize SBG, A and/or CCP as the **first DO missions**
- Missions to be **directed** to NASA Centers
- Instruments obtained through **partner contributions or competed AO**
- Spacecraft obtained through **partner contributions or RFP to industry**
- Rapid solicitation for **multi-Center** study proposals



April 2018 briefing to NASA Centers

Earth System Observatory

SURFACE BIOLOGY AND GEOLOGY

Earth Surface & Ecosystems

SURFACE DEFORMATION AND CHANGE

Earth Surface Dynamics

CCP

CLOUDS, CONVECTION AND PRECIPITATION

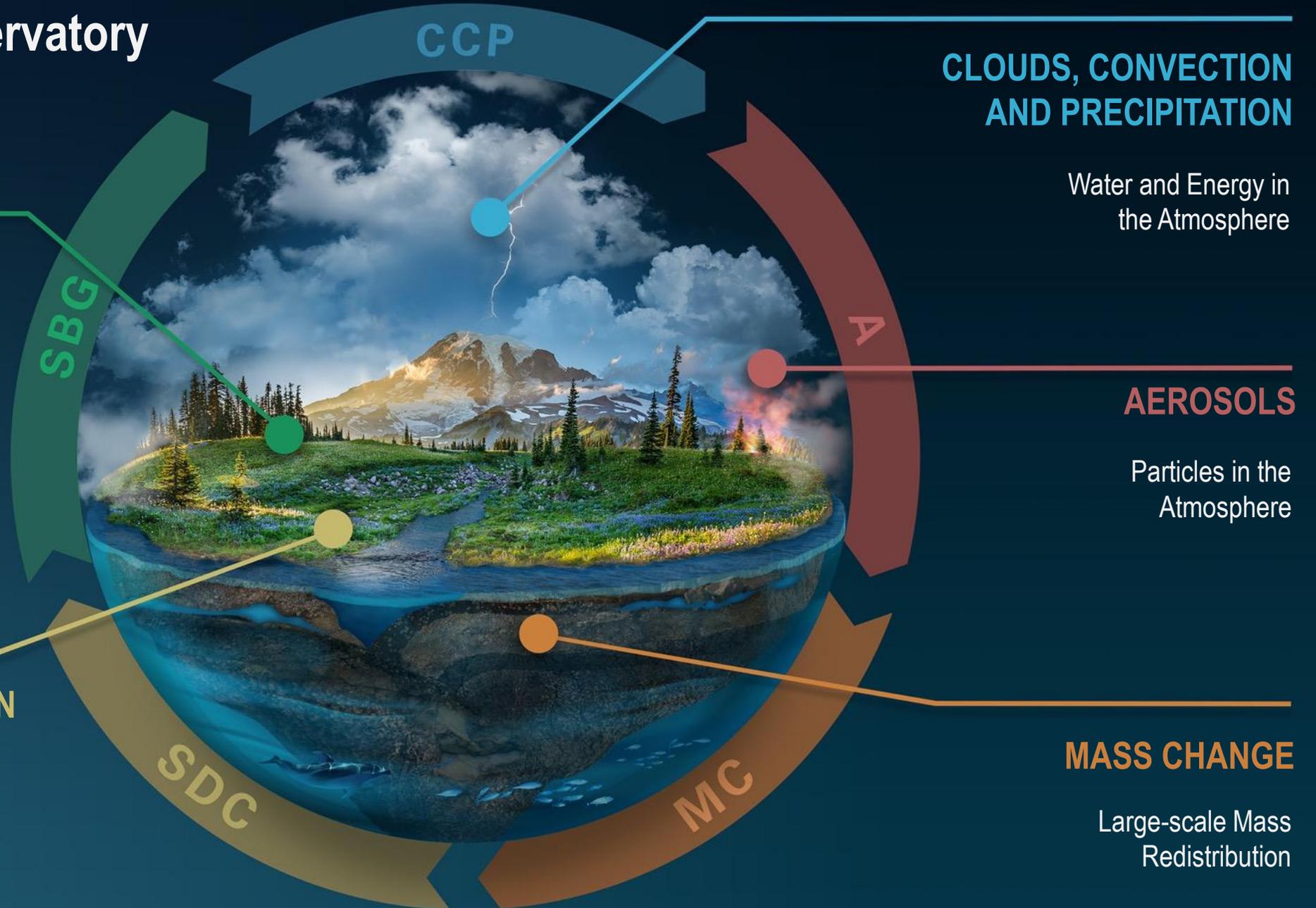
Water and Energy in the Atmosphere

AEROSOLS

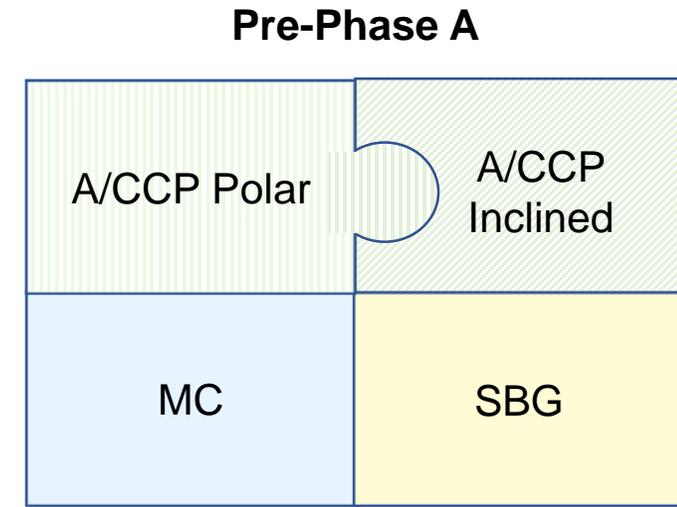
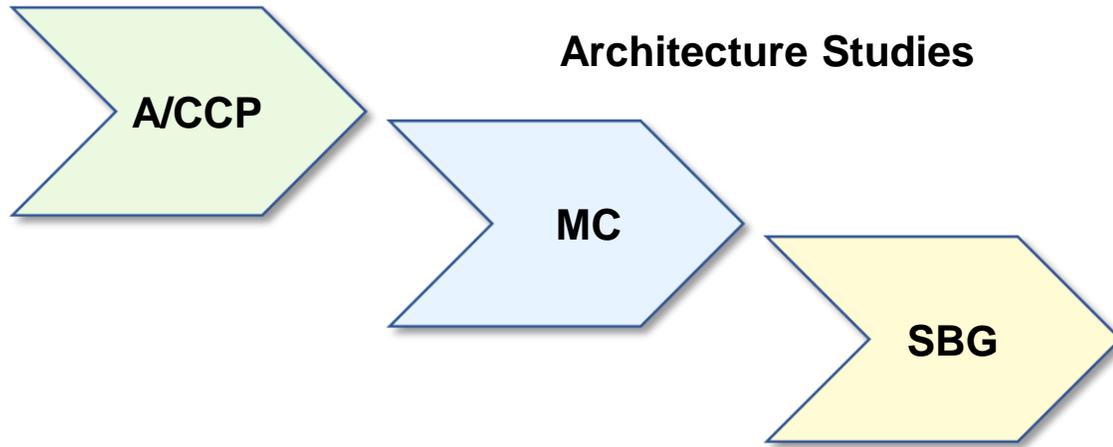
Particles in the Atmosphere

MASS CHANGE

Large-scale Mass Redistribution



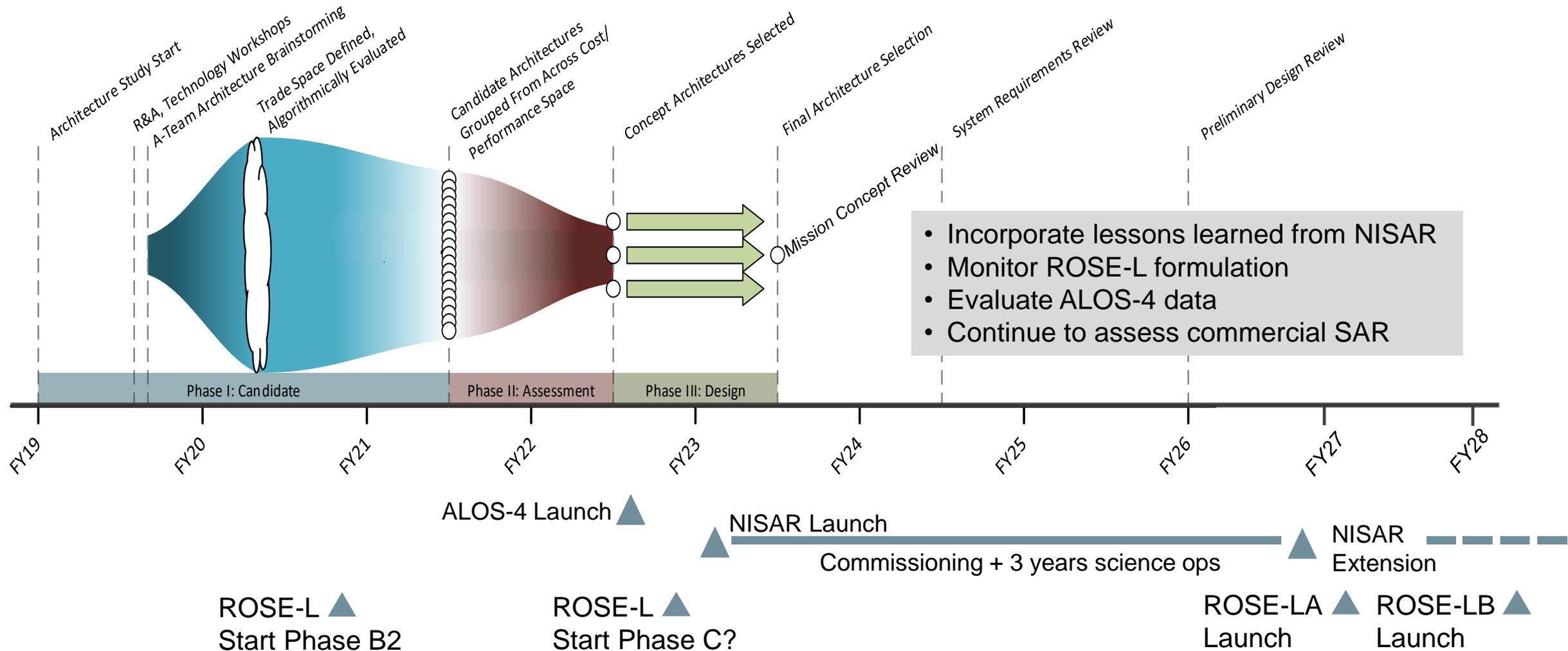
Transitioning from Architecture Studies to Pre-Phase A



Why Now?

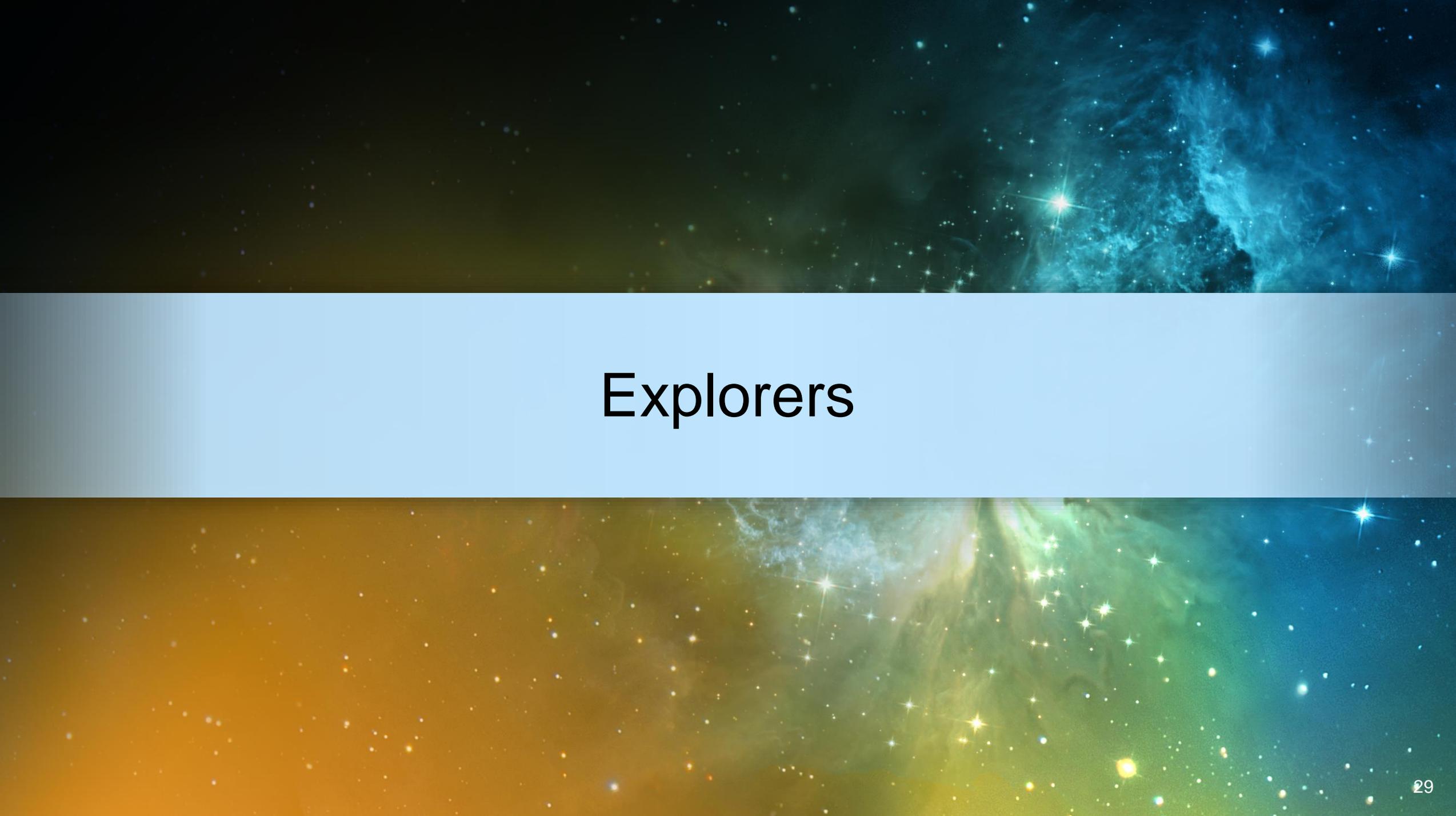
- This interconnected observatory represents a unique opportunity to observe the Earth as a system
- Maximizes science return with the overlap of as many elements as possible
- Builds on the momentum developed during the first two years
- Improves the likelihood of establishing its first elements before 2028

Why Not SDC Now?



Pre-Phase A & Beyond

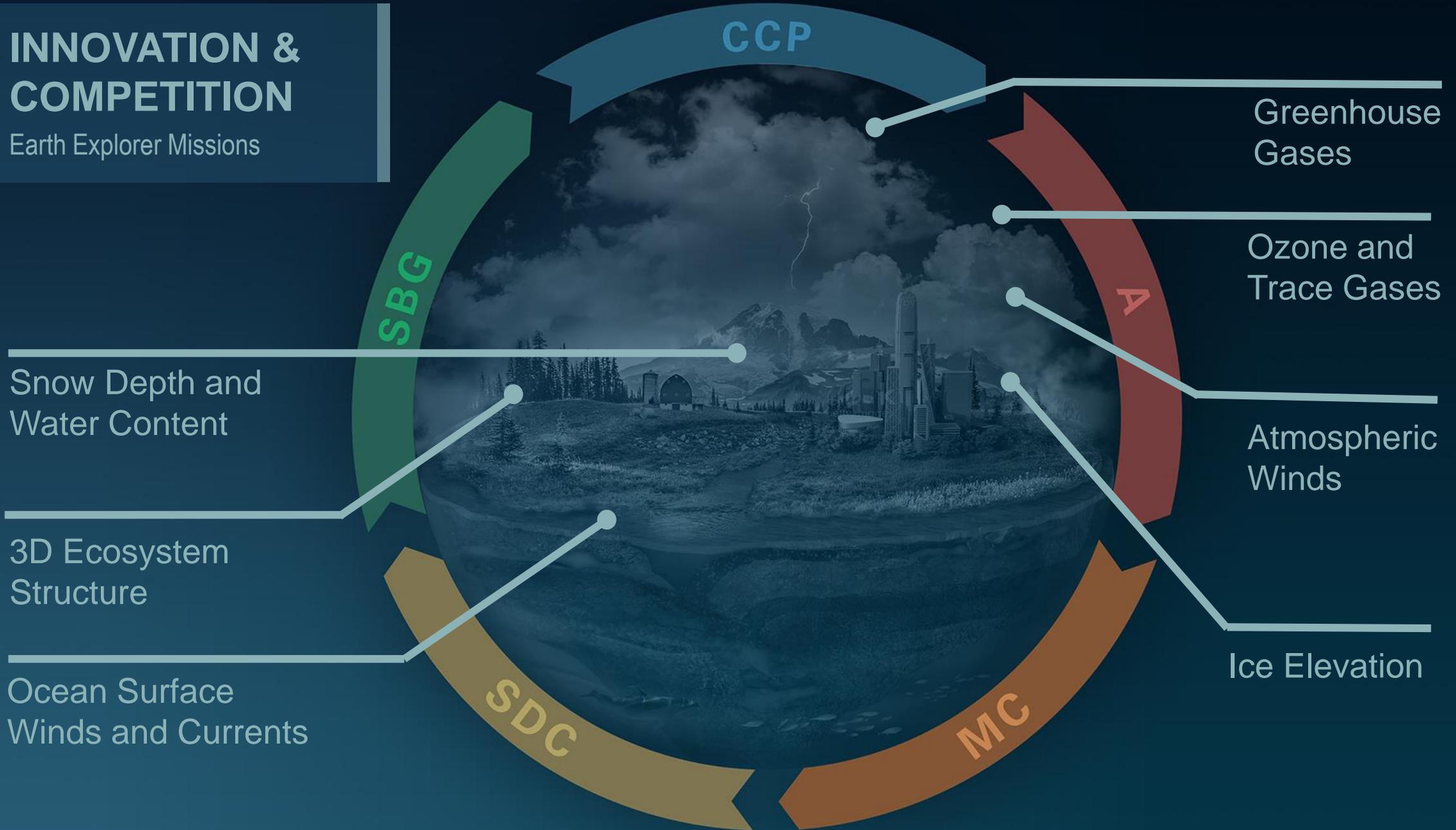
- Project Authorization Letters establish projects at JPL and GSFC, and direct the scope of work for Pre-Phase A
 - Define architecture path forward
 - Identify trade studies around that architecture
 - Define international partnerships
 - Open-source science
 - Applied Sciences
- Projects will “graduate” to Phase A with the successful completion of a Mission Concept Review and KDP-A, dependent upon:
 - Concept maturity
 - Continuity considerations
 - Available budget
 - Alignment with partnership opportunities

The background of the slide is a composite of two cosmic images. The top half features a dark space filled with numerous small, distant stars and a prominent, glowing blue nebula on the right side. The bottom half shows a similar starry field but with a warm, golden-yellow and greenish glow, suggesting a different spectral filter or a different region of space. The word "Explorers" is centered in a clean, black, sans-serif font across the light blue gradient band.

Explorers

INNOVATION & COMPETITION

Earth Explorer Missions



Status & Strategy

- The Decadal Survey recommended a new competed Earth System Explorer (ESE) flight element
- Suggested implementing 3 of 7 Targeted Observables as Explorers
- ESE will use a **two-step AO process**, similar to Explorer solicitations in other SMD divisions
 - \$350M cost-capped (including launch services) observing systems/missions
 - 9–14-month Phase A prior to down-select
 - First solicitation will likely allow proposals for any observable from the DS Explorers list
 - Subsequent ESE solicitations will likely restrict primary observable foci based on previous selections
 - ESD will encourage solicitations that address more than one ESE Observable and that support other aspects of the DS-recommended ESD portfolio
- New ESE Program Office to be established
- Implementation will be paced by availability of funds

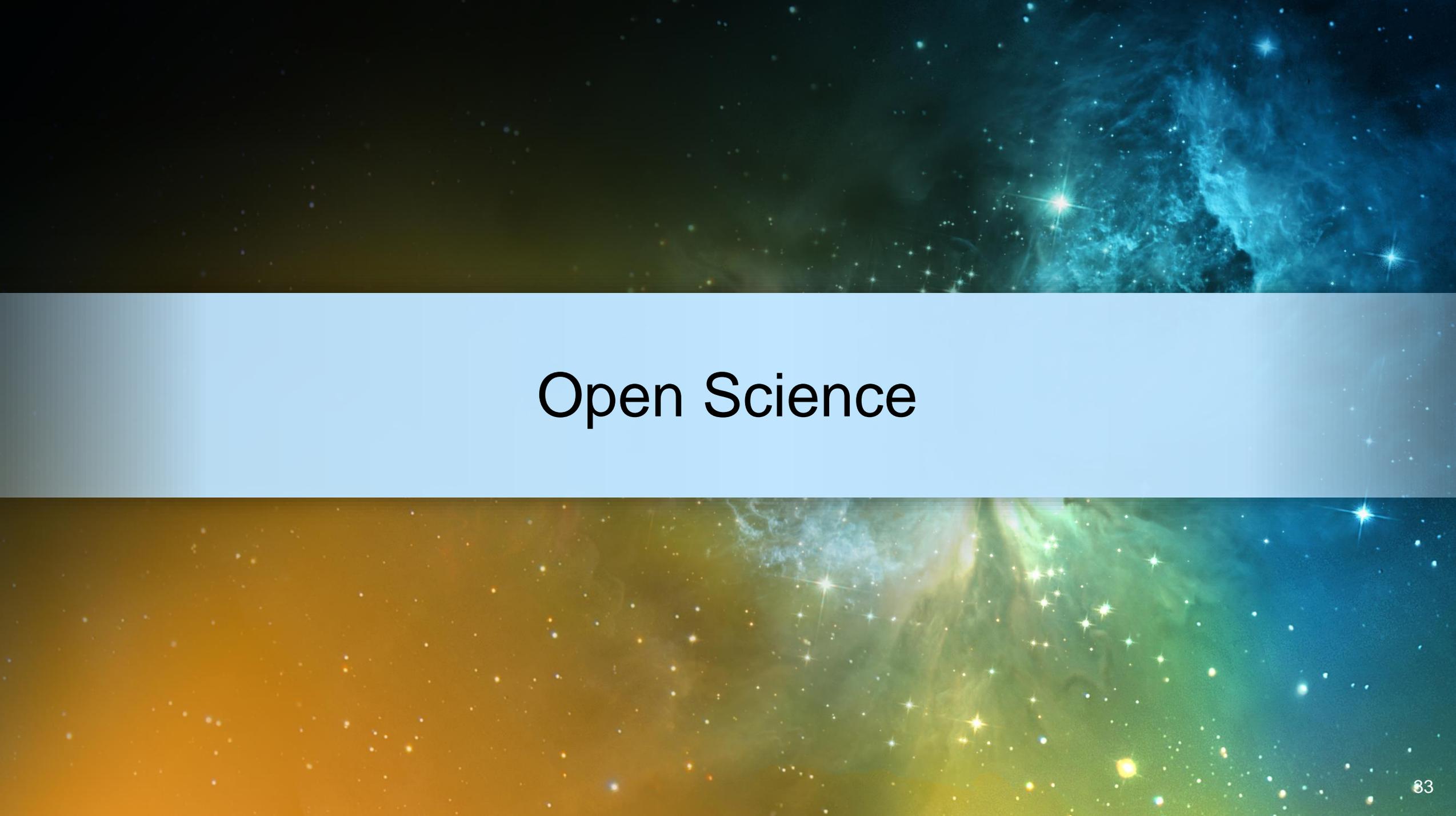
Explorers Technology Investments Position NASA for Success

Investments Made Since 2013



- Information Systems
- Observation Technology
- Technology Validation

- Solid circle indicates project solicited prior to 2017 Decadal Survey
- Ring shape indicates project solicited after release of 2017 Decadal Survey

The background of the slide is a cosmic scene. The top half features a dark blue and black space filled with numerous small stars and a prominent, bright blue nebula on the right side. The bottom half transitions into a warmer, golden-yellow and greenish space, also filled with stars and a nebula that glows with green and yellow light. A horizontal light blue band runs across the middle of the slide, containing the text.

Open Science

Chief Science Data Officer

- On March 5, ESD announced that **Kevin Murphy**, Program Executive for Earth Science Data Systems, was selected as its new and first Chief Science Data Officer
- Official start date was March 15
- The Chief Science Data Officer is responsible for leadership of SMD's data strategy and policy and the implementation of ESD's Data Program





Open Science by Design

Foundation for an Integrated Earth Observatory

A Vision for Open Sourced Science

Expand participation, improve reproducibility, and accelerate scientific discovery for societal benefit.

1
TRANSPARENT

3
ACCESSIBLE

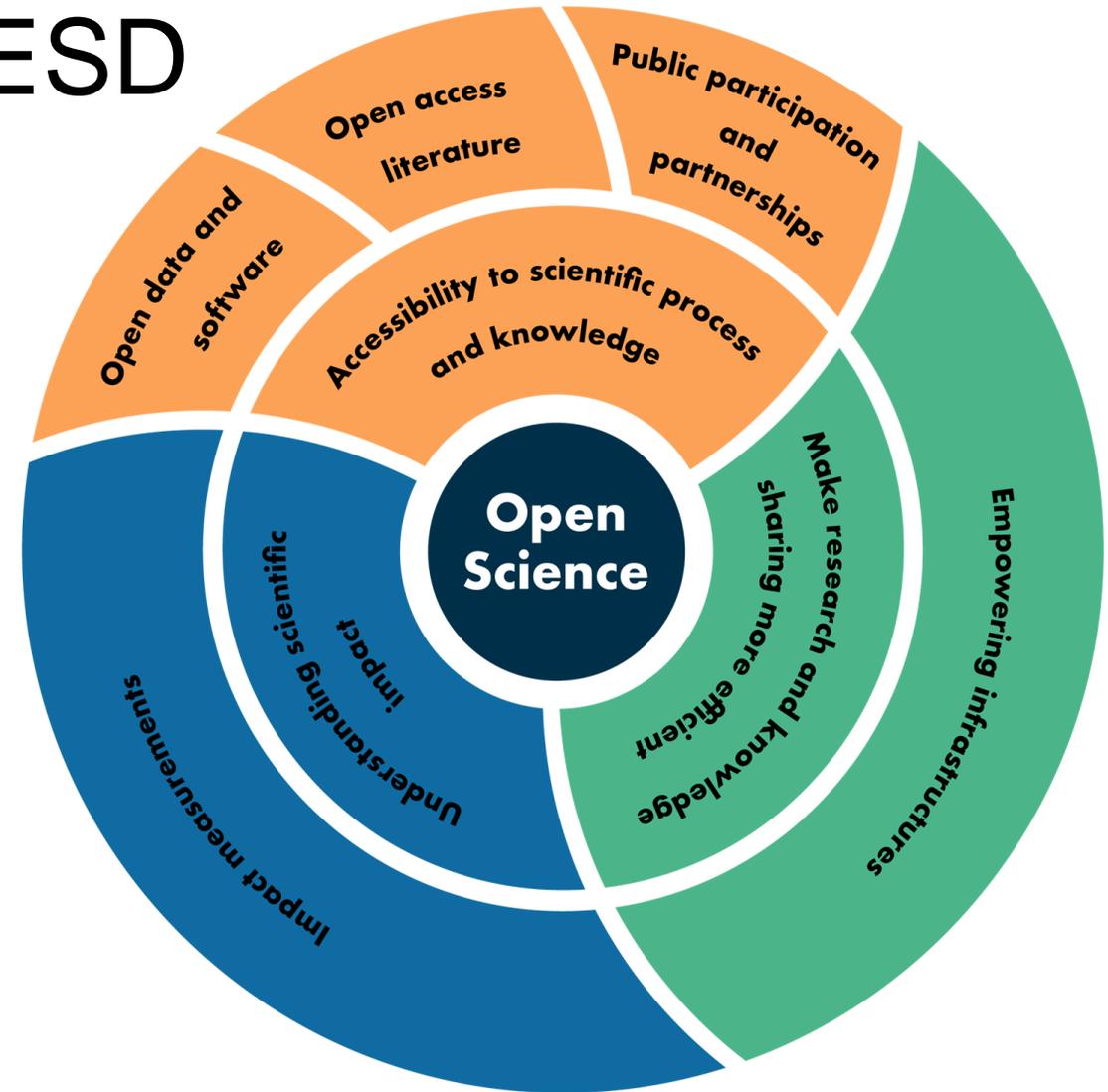
**OPEN SOURCED
SCIENCE
PRINCIPLES**

2
INCLUSIVE

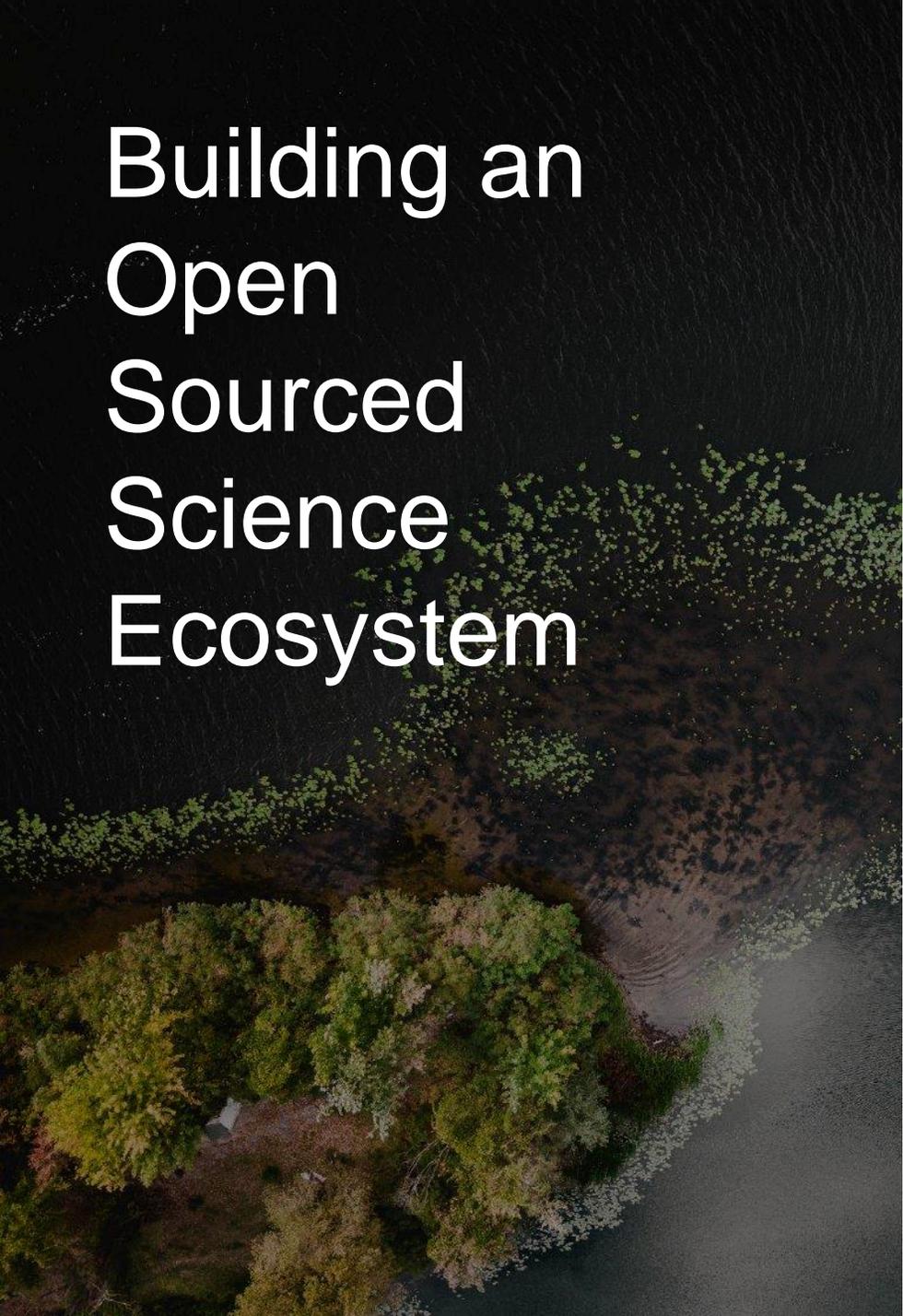
4
REPRODUCIBLE

Open Science Goals for ESD

*Open science is a collaborative culture enabled by technology that empowers the **open sharing of data, information, and knowledge** within the scientific community and the wider public to accelerate scientific research and understanding.*



Clear alignment with the SMD Strategy for Data Management and Computing

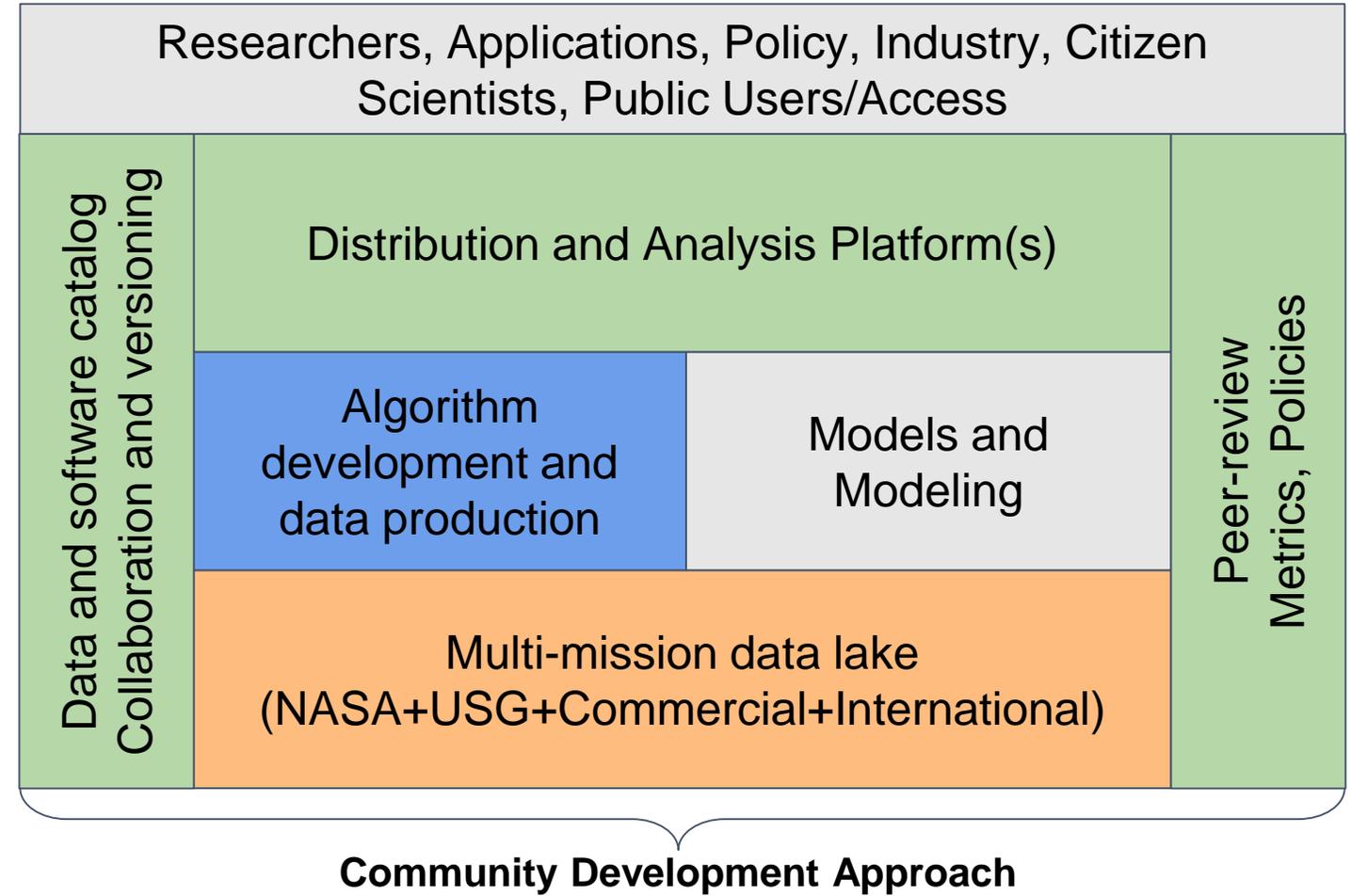
An aerial photograph showing a dense forest of green trees on the left, transitioning into a sandy or rocky shoreline that meets a body of water on the right. The water is dark and reflects the sky. The overall scene is a natural landscape.

Building an Open Sourced Science Ecosystem

- **Initiate** new missions, research, and applied activities as open science projects
- **Implement clear policies** for software, publications, and data
- **Integrate and improve** existing capabilities to support data management, access, computing, analytics, and collaboration
- **Build the community** through training, workshops, competitions, and incentives

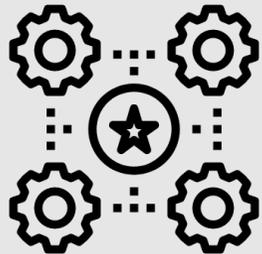
Open Sourced Science Components

An **integrated earth observatory** is at its heart a data system with capabilities to support sharing, stewardship, equitable access, and collaboration in support of research and applications activities.



Pre Phase-A Cross DO Study: Data Processing

Developing concepts for an open common science data processing system for product generation (L1 - 4).



Study facilitated and funded by Data Systems Program

Approach

- Initiate an architecture concepts and prototyping study co-led by JPL and GSFC with support from DO teams.

Expected DO Commitment

- .5 WYE and 3 workshops over 12 month period

Deliverable

- Architectural options for an open common science data processing system for L1 - 4 products that identifies risks, incentives and potential partnerships.

Ground Rules for Cross DO Study

- Missions will be responsible for costs of generating science products.
- Missions will adhere to open data, software, algorithm, and publication policies (i.e. SMD Information Policy currently in draft form).
- Missions will develop algorithms, software, and documentation in open systems from the start (Level 1 - 4).
- Earth Science Data System (ESDS) Program will be responsible for stewardship (software, documentation, and data), archival, distribution, user support, and publicly available analysis capabilities.
- Efforts should focus on identifying and reusing suitable existing capabilities.





In Summary

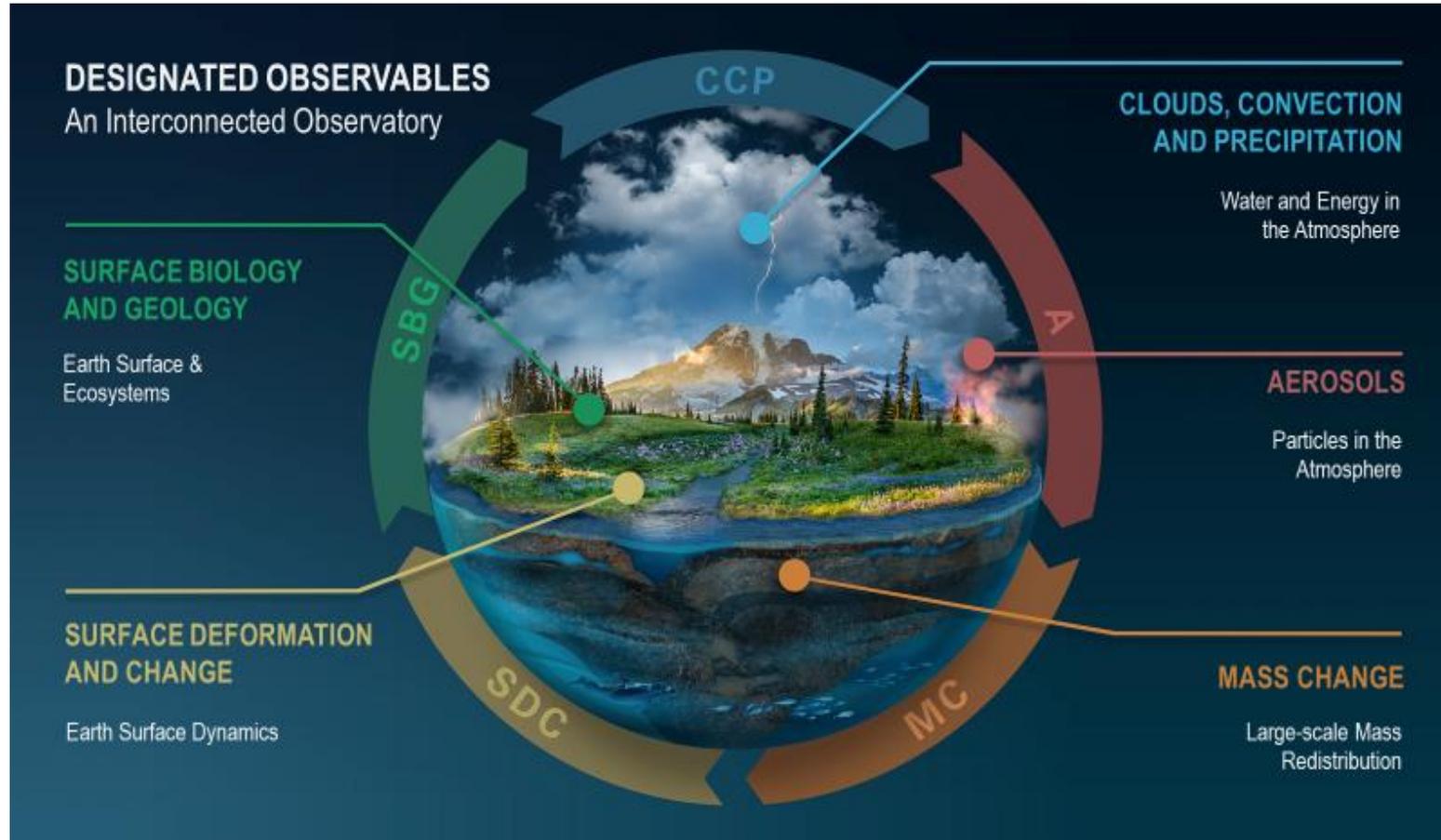
We have a strong vision for the future and have been making strides towards open science.

For DOs entering Pre-Phase A, we have an opportunity to build-in open science principles at project initiation to tackle common challenges and in turn, build a community dedicated to transparency, inclusivity, accessibility, and reproducibility.

The background of the slide is a cosmic scene. The top half features a dark blue and black space filled with numerous small stars and a prominent, glowing blue nebula on the right side. The bottom half transitions into a warmer color palette, with a golden-yellow and greenish glow, also containing stars and nebulae. A light blue horizontal band is positioned in the center, containing the title text.

Interactions of Applications and Research

Interactions of Applications and Research



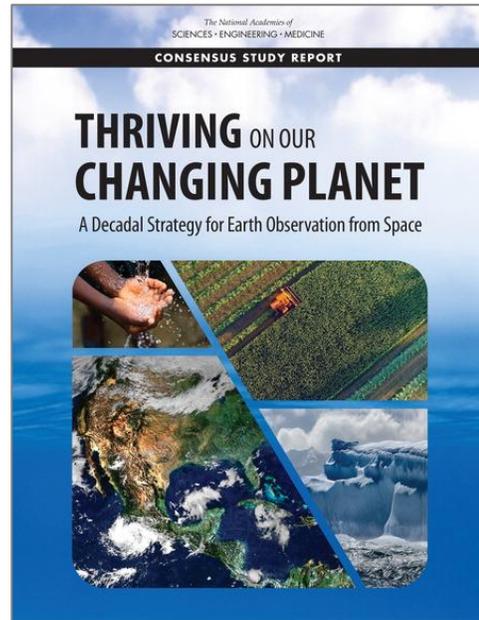
*Research and Applied have **fundamentally worked differently** on SBG than ever before.*

I think it's true for all DOs.

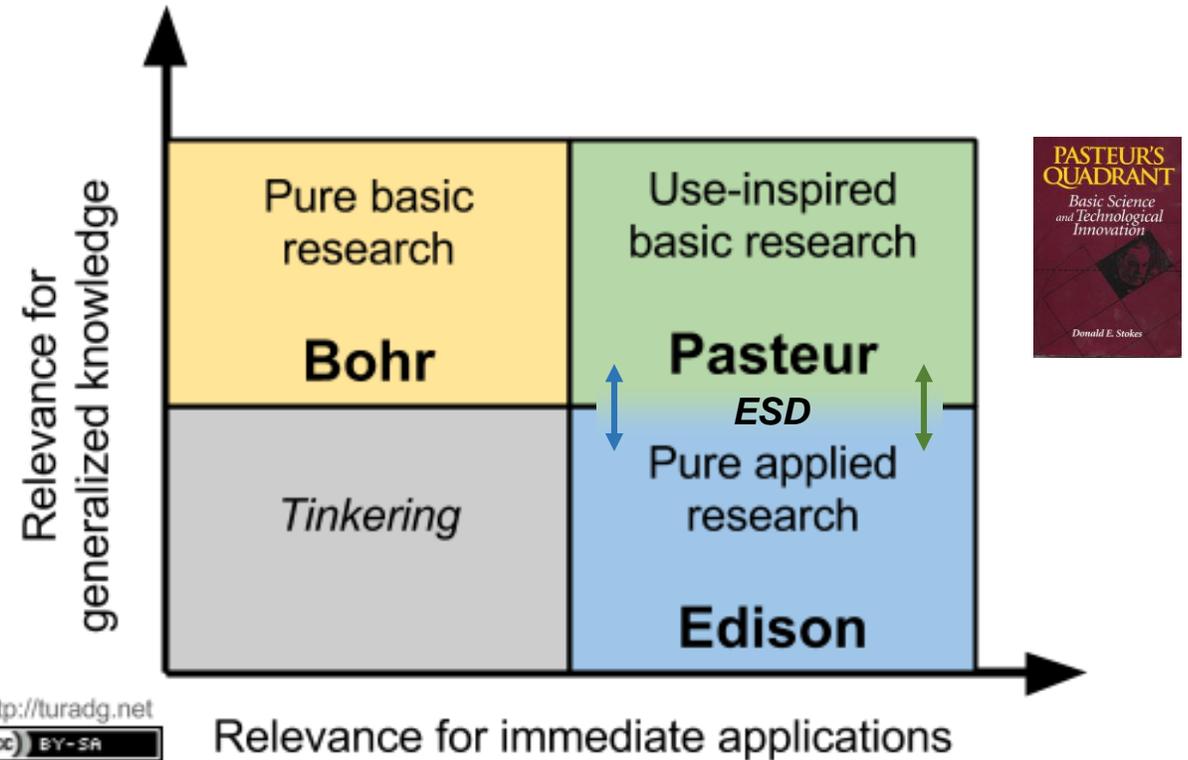
– Woody Turner

Community Challenge

“Pursue increasingly ambitious objectives and innovative solutions that enhance and accelerate the science/applications value of space-based Earth observation and analysis to the nation and to the world...”



“To its credit, NASA has increasingly integrated applications into flight programs and research, with results that have been embraced by both the science and applications communities.” p.61



Note: This figure did not appear in the Earth Decadal Survey

DOs, Research, Applications

Applications ↔ *Research*

Maximize the return on NASA's investments by enhancing scientific knowledge, applications value, and overall societal benefits of the Designated Observables to broad audiences

User Communities

Uses of data and information products to improve decisions for societal and economic benefits. Feedback from non-traditional audiences. Expand ROI beyond research and new knowledge of Earth

Earth Science Knowledge

Research results and some co-production. Broader sector awareness and familiarity with research pursuits of DOs & researchers. Build anticipation of research results and identify new research pursuits

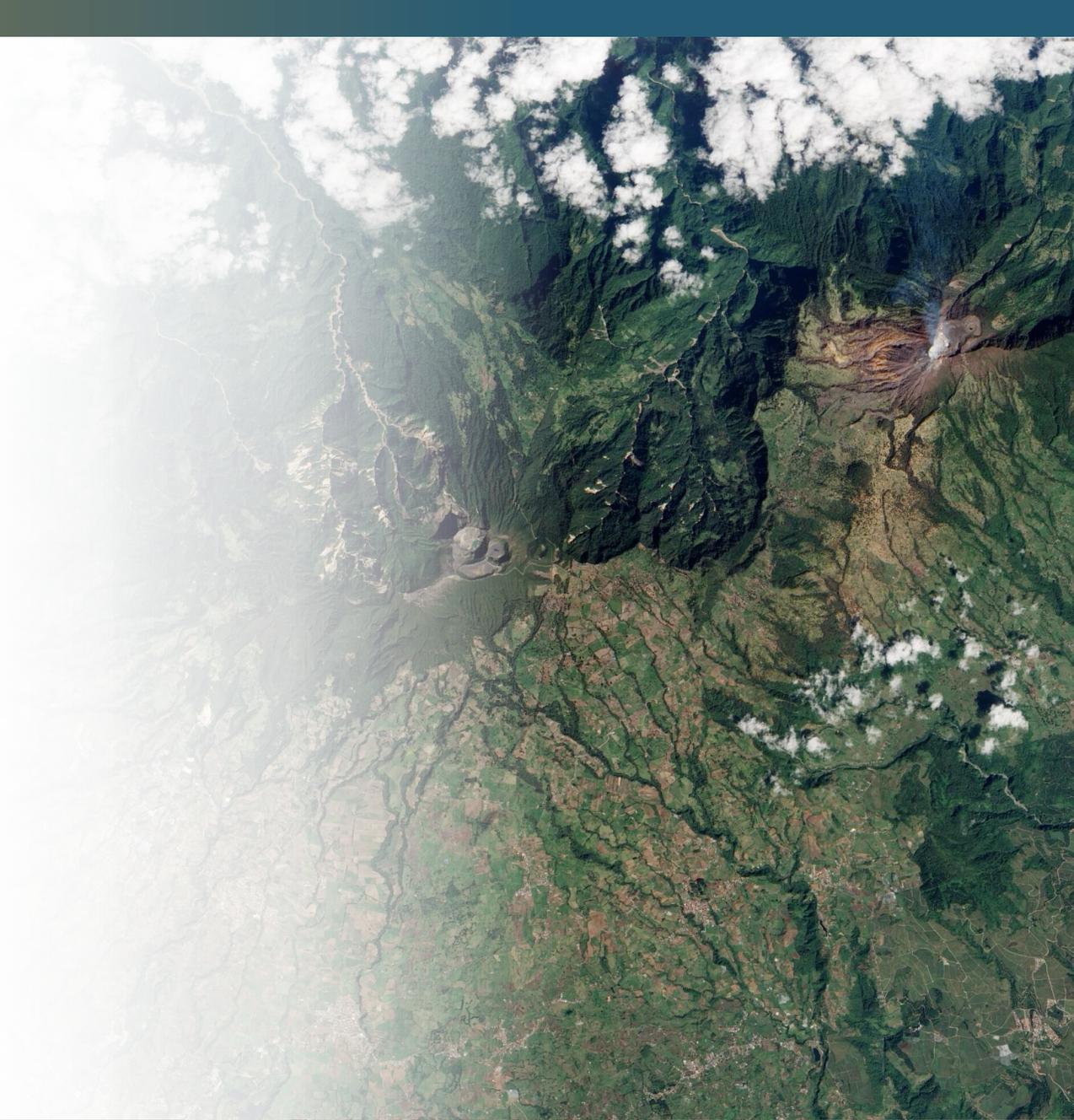
Stakeholders

Broaden the range of communities and organizations that are aware of and interested in the NASA mission plans

Interactions of Applications
and Research

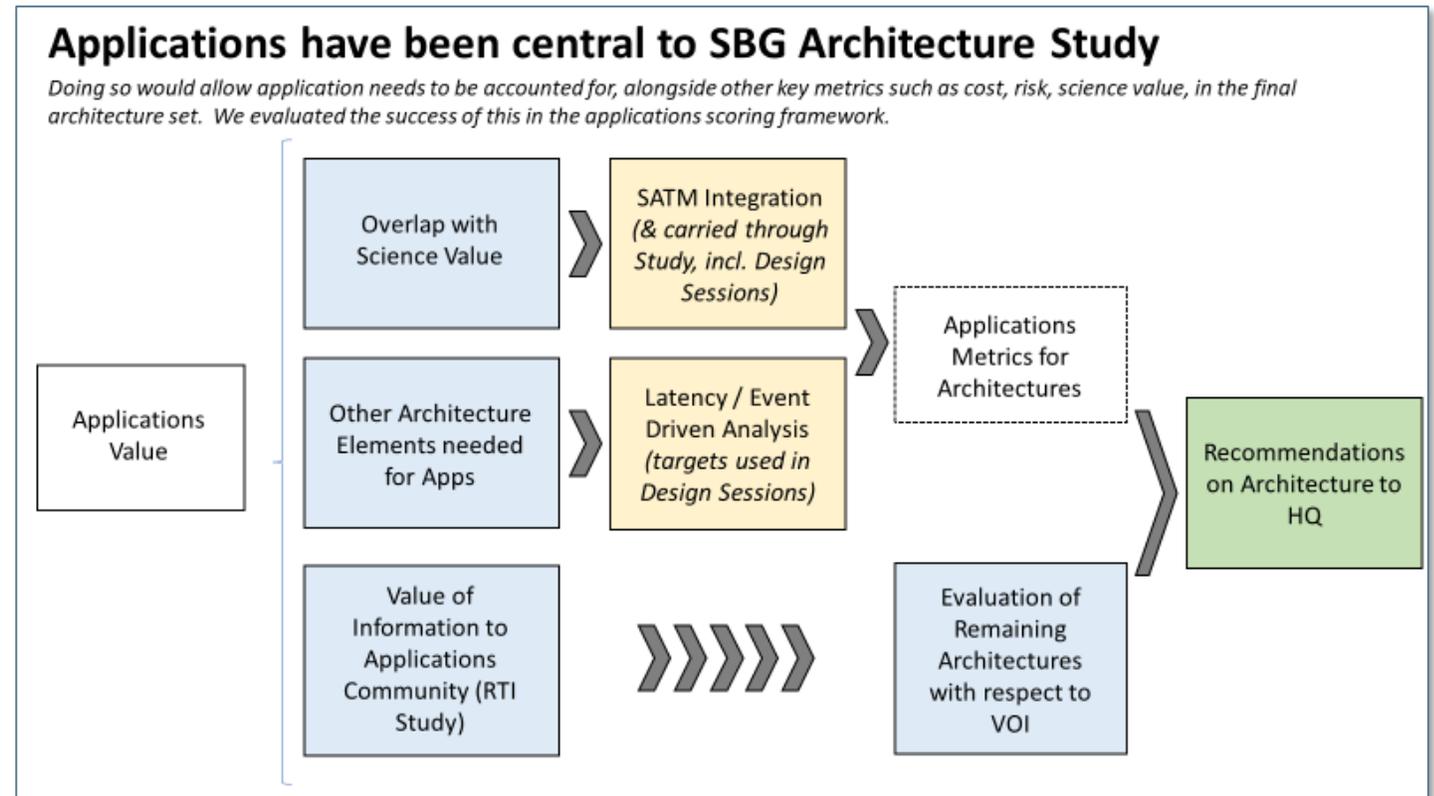
What Does This Look Like

DO Studies



Approach

- Joint (research/applications) teams
- Clear mapping of applications integrations
- Science and Application Traceability Matrices (SATMs)
- Community engagement
- Integrated architecture evaluation

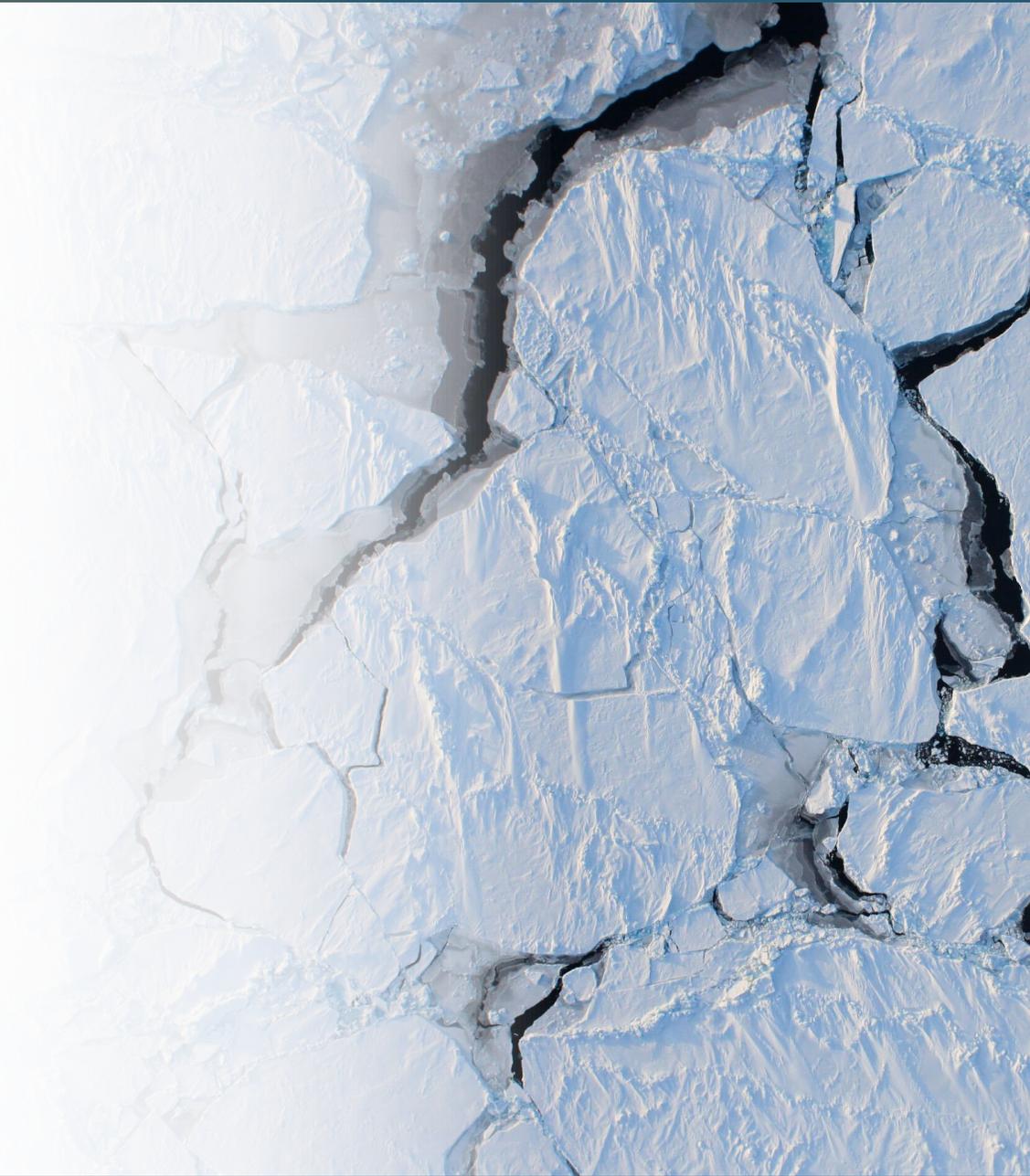


Example of clear mapping of applications integrations with SBG.

Interactions of Applications
and Research

What Will This Look Like

Pre-Phase A and Beyond



What will this look like ...

Mission Products, Science Teams, and More

Mission Products

- Deliberate approach to mixture of low-level and high-level data products to serve range of researchers and users; algorithm development
 - *Open science possibilities*

PLRA and Level 1 Requirements

- Integration of applications

Pre-launch data

- Significant, deliberate efforts for proxy data, simulated data, airborne data

Early Adopters

- Implement revamped program, including clear expectations on Science Team members to engage with EAs

Science Teams:

Composed of people spanning expertise in research, applied research, and applications

- *Pre-Launch Teams*: People who can work data product developments to address needs across research and user communities; Applications Working Group as standard element
- *Post-Launch Teams*: Need to move from a varied, ad hoc approach to design deliberate efforts enabling a mixture of perspectives. Applications Working Group as standard element (opt-out)

What will this look like ...

Community Assessment Reports

- In Pre-Phase A, Earth science projects produce a Community Assessment Report (CAR) to document information about relevant applications communities
- The CAR characterizes the communities, including technical and organizational aspects. The projects use the information as part of mission concept decisions.
 - RTI International contractor supporting each project team in creating the CAR in Pre-Phase A
- The CAR serves as a reference document for the project team, PE, PS, PAL, and others throughout the lifecycle. Info may be relevant to any phase of the lifecycle – not just Pre-Phase A.



The *ESD Directive on Project Applications Program* stipulates a CAR in Pre-Phase A

What will this look like ...

Building on Established Capabilities

SBG

- SISTER Project
- Western bioDiversity Time Series data acquisition
- ECOSTRESS: Science and Applications Team
- Early Adopters
- Joint meetings of Biodiversity program (R&A) and Ecological Forecasting program (Applied Sciences)

A/CCP

- Health & Air Quality Applied Sciences Team: Researchers meeting with Managers, Officials, Users
- TEMPO Early Adopters
- MAIA Early Adopters
- GPM Applications
- FIREX-AQ Community

MC

- High Mountain Asia: Projects and community of researchers and applications specialists; joint leadership by R&A and AppSci
- GEWEX Program
- USGS Groundwater Census
- GRACE-FO Science Team: Includes 2 people with applications experience
- Relationship with California Dept of Water Resources
- Space Geodesy

What will this look like ...

Continuing & New Cross-Benefits

A/CCP

Continuing topical workshops

- Continue audience engagement and CAR development
- Further collaborations between Health and AQ Applications, Tropospheric Composition, Radiation Sciences, and Weather research
- Follow-up with communities already engaged
 - Air Quality Workshop March 2021: End users engaged with study team members
 - Transportation Logistics Workshop Nov 2020: Insights on transport and logistical activities for aviation, maritime, roads and highway systems with Study Team

SBG

Further development of methods for joint basic and applied research

- Example: Both increase our understanding of the geophysics of volcanoes while simultaneously gauging the extent of the hazard they pose to surrounding communities

Foundations & Philanthropies

“...a successful process for exploiting external trends might include at a minimum, a survey of ...non-traditional partnerships such as philanthropists and nonprofits”

2017 Decadal Survey

Exploring Opportunities to:

- Accelerate the rate of scientific discovery
- Pursue bigger and more complex science questions
- Drive development of technology, data and science applications
- Stimulate and open up new lines of scientific application
- Force-multiply the impact of the Earth Observation sector by synergizing public and private investments

Currently exploring opportunities with

BILL & MELINDA
GATES foundation



SCIENCE
PHILANTHROPY ALLIANCE

PLACEFUND

FLATIRON
INSTITUTE
Division of Simons Foundation



The background of the slide is a cosmic scene. The top half features a dark blue and black space filled with numerous small stars and a prominent, glowing blue nebula on the right side. The bottom half transitions into a warmer, golden-yellow and greenish space, also filled with stars and a glowing greenish nebula on the right. A horizontal light blue band runs across the middle of the slide, containing the title text.

Incubation Program

Study Team Report Update

PBL and STV reports to be available at NASA HQ Decadal Survey Website by week's end (4/16)!

National Aeronautics and Space Administration 

TOWARD A GLOBAL PLANETARY BOUNDARY LAYER OBSERVING SYSTEM

THE NASA PBL INCUBATION STUDY TEAM REPORT



João Teixeira ⁽¹⁾, Jeffrey R. Piepmeier ⁽²⁾, Amin R. Nehrir ⁽³⁾, Chi O. Ao ⁽¹⁾, Shuyi S. Chen ⁽⁴⁾, Carol A. Clayson ⁽⁵⁾, Ann M. Fridlind ⁽⁶⁾, Matthew Lebsock ⁽¹⁾, Will McCarty ⁽²⁾, Haydee Salmun ⁽⁷⁾, Joseph A. Santanello ⁽²⁾, David D. Turner ⁽⁸⁾, Zhien Wang ⁽⁹⁾, Xubin Zeng ⁽¹⁰⁾

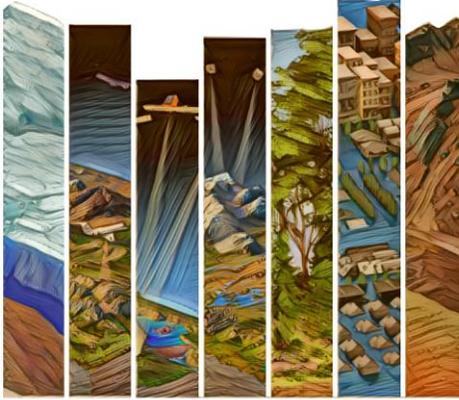
⁽¹⁾ NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA
⁽²⁾ NASA Goddard Space Flight Center, Greenbelt, MD
⁽³⁾ NASA Langley Research Center, Hampton, VA
⁽⁴⁾ University of Washington, Seattle, WA
⁽⁵⁾ Woods Hole Oceanographic Institution, Woods Hole, MA
⁽⁶⁾ NASA Goddard Institute for Space Studies, New York, NY
⁽⁷⁾ Hunter College, CUNY, New York, NY
⁽⁸⁾ NOAA Global Systems Laboratory, Boulder, CO
⁽⁹⁾ University of Colorado, Boulder, CO
⁽¹⁰⁾ University of Arizona, Tucson, AZ

<https://science.nasa.gov/earth-science/decadal-pbl>

National Aeronautics and Space Administration 

OBSERVING EARTH'S CHANGING SURFACE TOPOGRAPHY AND VEGETATION STRUCTURE

A FRAMEWORK FOR THE DECADE



NASA's Surface Topography and Vegetation Incubation Study
White Paper
April 2021

<https://science.nasa.gov/earth-science/decadal-stv>

ROSES-21 DSI Solicitation

- **DSI-21 to be released in late Spring 2021 as an amendment to ROSES (element A.45)**
- NASA will utilize Study Team Reports to inform DSI-21 development
- ESTO and Science groups working jointly to develop DSI-21 contents
 - Since drafting has begun, few details can be discussed at this time
 - Anticipate allowing for awards in *Science* and *Technology*
 - Technology awards will be similar in size to an Advanced Component Technology (ACT) task; science awards similar in size to R&A awards.
- Selections anticipated early CY 2022; new awards expected to begin ~Feb-Mar 2022
- ESTO will manage technology awards; R&A will oversee science awards. All tasks will report in the ESTO Reporting System (ERS)

Instrument Incubator Program IIP-21, ROSES (element A.41) release is imminent. It will allow for proposals that can support PBL or STV.

The background of the slide is a composite of two cosmic images. The top half features a dark blue and black space filled with numerous small stars and a prominent, bright blue nebula on the right side. The bottom half shows a similar starry field but with a warm, golden-yellow and greenish glow, suggesting a different spectral filter or a different region of space. The text 'What's Next' is centered in a white, sans-serif font across the middle of the slide.

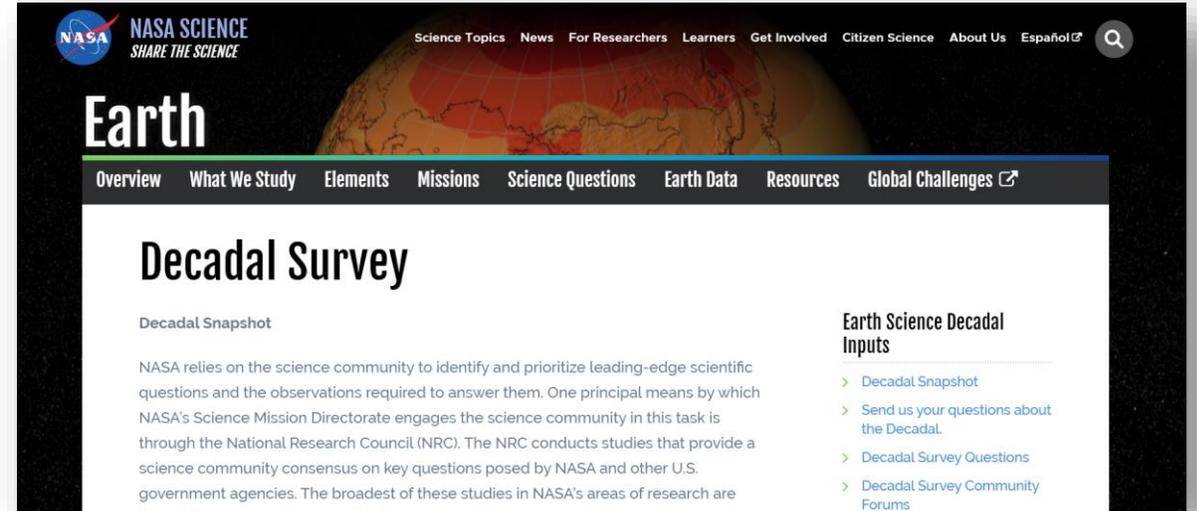
What's Next

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
- Next Community Forums
 - July 15, 2021; 1-3 p.m. EST
 - November 18, 2021; 1-3 p.m. EST
 - 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



The background of the slide is a composite of two cosmic images. The top half features a dark space filled with numerous small stars and a prominent, glowing blue nebula on the right side. The bottom half shows a similar starry field but with a warm, golden-yellow and greenish glow, suggesting a different nebula or a different spectral filter. The text 'Q&A' is centered in a white, sans-serif font on a light blue horizontal band that spans the width of the slide.

Q&A

Questions Process

- Please type your question directly in the Q&A panel
- Or you can email questions to Molly Olonoff at Molly.L.Olonoff@nasa.gov
- Answers to relevant questions will be posted on our website: <https://science.nasa.gov/earth-science/decadal-surveys>

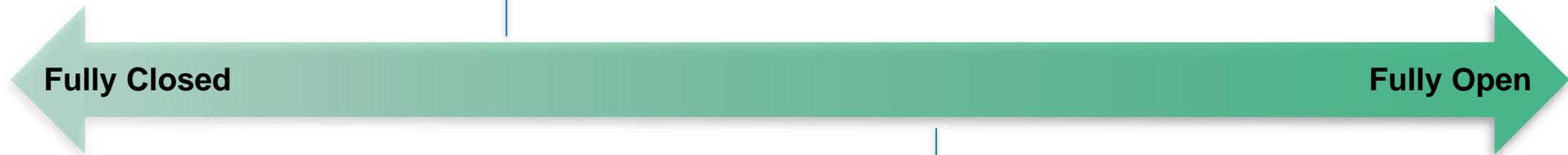
The background of the slide is a composite of two cosmic images. The top half features a dark space filled with numerous small stars and a prominent, glowing blue nebula on the right side. The bottom half shows a similar starry field but with a warm, golden-yellow and greenish glow, suggesting a different nebula or star formation region. The word "Backup" is centered in a white, sans-serif font across the middle of the image.

Backup

A Continuum of Open Sourced Science

- Data access (\$\$)
- Accessible publications (\$\$)
- Siloed systems
- Limited Communication
- Proprietary Software
- “Closed-tent” culture

- Free unlimited data access
- Fully documented open software and algorithms
- Fully linked data and publications
- Open Access Journal Publications
- Fully Transparent Processes
- Reproducible across platforms
- “Teaching” Culture



Fully Closed

Fully Open

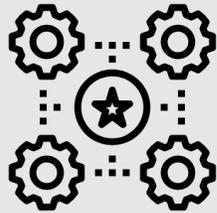
- No public data access
- No publications
- No insight into processes
- No reproducibility
- “Black Box” Culture

- Free data access
- Open software and algorithms
- “Green” Journal Publication
- Documented Processes
- Reproducible in specific environments
- “Open-Tent” Culture

Investments in Open Sourced Science

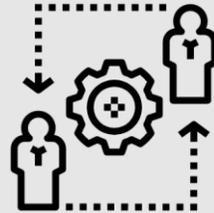
Cross DO Study: Data Processing

Developing concepts for a common science data processing system for product generation.



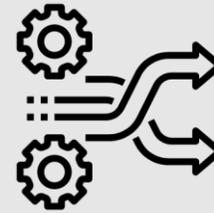
Cross Agency Partnering: NOAA

NASA/NOAA joint cloud-based data lake pilot motivated by needs of both agencies



Improve Existing Capabilities

Multi-Mission Algorithm and Analysis Platform (MAAP) will be expanded to include support for hybrid compute environments, especially for HEC.



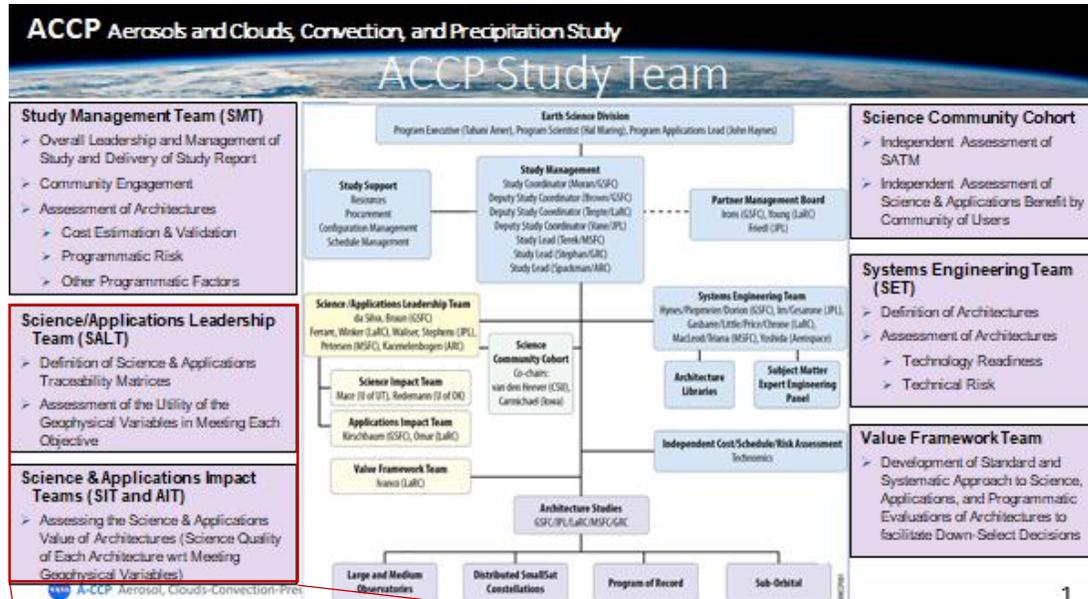
Cross DO Study: Data Latency

Evaluating flight hardware and ground system architectures to minimize product latency across DOs.



What does this look like ...

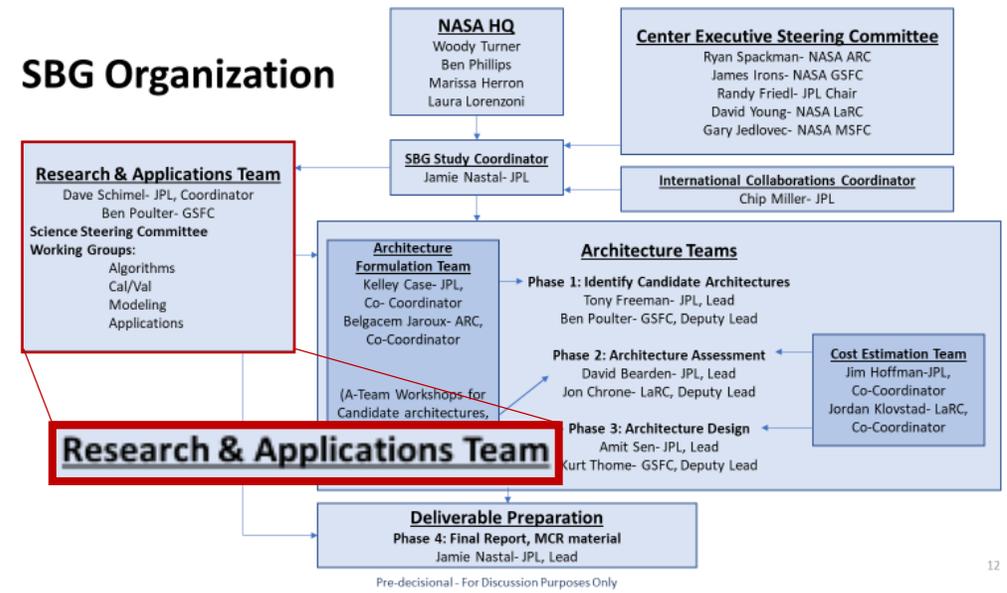
Joint Teams



Science/Applications Leadership Team (SALT)

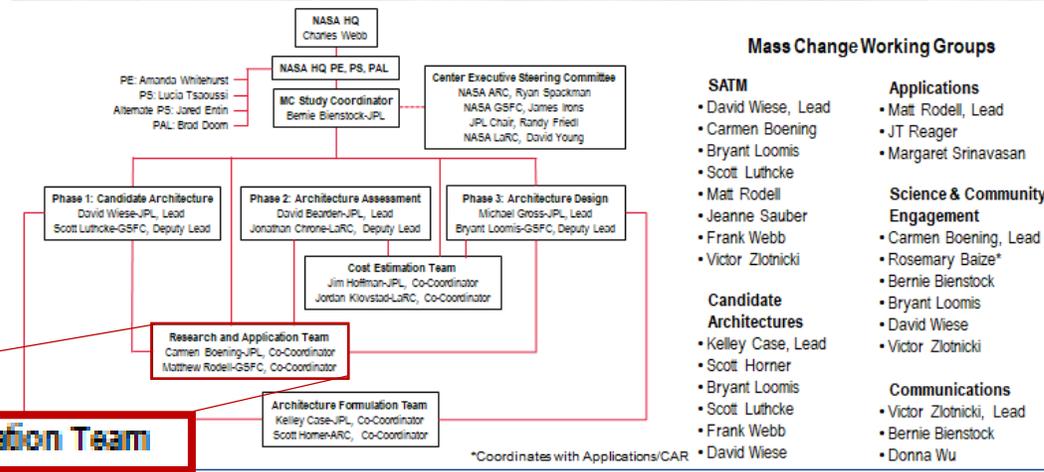
Science & Applications Impact Teams (SIT and AIT)

SBG Organization



Research & Applications Team

Mass Change Phase Org Chart



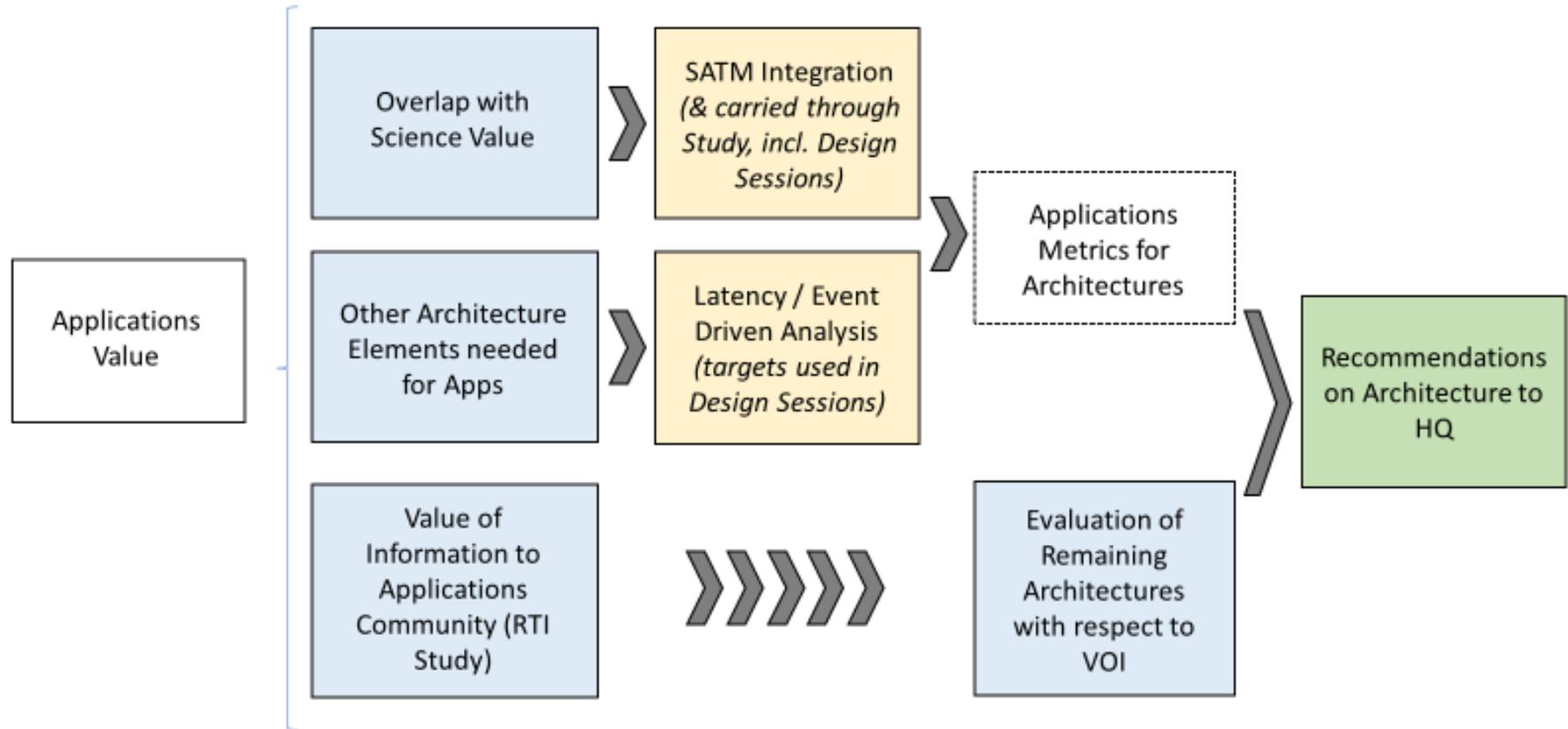
Research and Application Team

What does this look like ...

Clear Mapping of Applications Integration

Applications have been central to SBG Architecture Study

Doing so would allow application needs to be accounted for, alongside other key metrics such as cost, risk, science value, in the final architecture set. We evaluated the success of this in the applications scoring framework.



What does this look like ...

Community Engagement

ESD Community Forums

Address cross-benefit of research and applications

A/CCP

ACCP Community & Stakeholder Feedback

- Over 110 workshop attendees and surveys solicited
- Over 60 independent interviews
- Engagement with National/International agencies and the private sector

ACCP Stakeholder Workshops

- Weather and Air Quality Modeling (7/2019)
- Transportation and Logistics (11/2020)
- Air Quality (3/2021)

Science Conference Engagements

- AGU, AMS, Community Forums, HAQAST Workshops, GPM Science Team, International Association of Wildland Fire, CALIPSO Science Team

Interviews with Communities of Practice and Potential

Surveys and Trainings

- Weather and AQ modeling community
- ARSET GPM training

The infographic features a central collage of logos from various organizations, including METEO FRANCE, 気象庁 (Japan Meteorological Agency), National Environmental Satellite Data and Information Service, NIH, UAS, NOAA, FATHOM SCIENCE, ECMWF, WORLD RESOURCES INSTITUTE, CIRA, CPC, UPS, SWISS RE, UNITED, US Army Corps of Engineers, and Earth System Research Laboratory.

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- Community workshops & webinars
- Topical seminars
- Individual interviews
 - 562 respondents in broad survey; 40 in-depth interviews
- Social media (website, blog)
- Remote sensing training
- Town Halls, conference participation
- Pathfinder activities

All DOs: Audience Engagement Support

Contracted with RTI International to support all of the DO Study Teams:



- Characterize user communities, especially industries and private companies
- Expand beyond traditional audiences
- Support development of Community Assessment Reports (Pre-Phase A req)
- Compile information to inform architectures and mission concept

What does this look like ...

Integrated Architecture Evaluation

MC

Research Areas and Applications integrated in Science Value assessment of Architectures

Science Value Highlights

	Architecture 1 capabilities	Architecture 2 capabilities (in addition to Architecture 1)
Baseline science objectives	Meets (roughly corresponds to quality of program of record)	Exceeds by factor of 4
Global spatial resolution	(430) ² km ² for monthly solutions at 15 mm equiv. water height	(195) ² km ² for monthly solutions at 15 mm equiv. water height
Global temporal resolution	Nominally Monthly	Nominally Bi-Weekly
Cryosphere	<ul style="list-style-type: none"> Mass balance of largest ice sheet drainage basins in Greenland and Antarctica 	<ul style="list-style-type: none"> Mass balance of individual ice sheet drainage basins and mountain glacier systems, supporting their modeling and prediction
Hydrology	<ul style="list-style-type: none"> 20% of global water budget Closure of water budget at smaller scales Understanding of hydrological cycle at large scales 	<ul style="list-style-type: none"> 85% of global hydrological basins observed Closure of water budget at smaller scales: (195)² km² Improved data assimilation into hydrology models Improved estimates of groundwater changes
Oceanography	<ul style="list-style-type: none"> Separation of mass and steric sea level at regional scales Improved understanding of ocean-atmosphere heat fluxes Measurement of the Antarctic Circumpolar Current (ACC) 	<ul style="list-style-type: none"> Separation of mass and steric sea level at regional scales; improves understanding of ocean-atmosphere heat fluxes Measurement of the Antarctic Circumpolar Current (ACC)
Solid Earth	<ul style="list-style-type: none"> Monitoring of earthquakes of Magnitude > 7.0 (~12 events/year) Separation of tectonic, GIA, hydrological, and cryospheric signals Deep interior properties and dynamics 	<ul style="list-style-type: none"> Monitoring of earthquakes of Magnitude > 7.0 (~12 events/year) Separation of tectonic, GIA, hydrological, and cryospheric signals Deep interior properties and dynamics
Applications	<ul style="list-style-type: none"> Spatial resolution benefits all applications Water management on smaller scales Operational forecasting/early-warning of flood events and droughts Hazard mitigation: weather services; fire risk; earthquake assessment 	<ul style="list-style-type: none"> Improved latency and spatial resolution benefits all applications Significant contributions to water management on smaller scales Operational forecasting/early-warning of flood events and droughts Hazard mitigation: weather services; fire risk; earthquake assessment

Baseline science objectives

Global spatial resolution

Global temporal resolution

Cryosphere

Hydrology

Oceanography

Solid Earth

Applications

Relevant citations: IUGG Report, Observing Earth and Global Change and to Benefit Society, 2016; IGSSWG Final Report, Toward a Next Generation Earth Observing Constellation (MAGIC), 2020

10/30/20 15

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Science Value, Applications Value, and Community Assessment integrated in Architecture Evaluation

Summary	Recommendation: Two-Platforms	Alternative 1: One-Platform	Alternative 2: Constellation
Science value	8.56	7.43	8.06
Applications value	TIR coincidence with VNIR	Non-optimal crossing time for TIR, loses afternoon observation (key science objective)	High value but challenging VSWIR multi-instrument calibration and validation
Community assessment * Best-case	Provides most science value and lowest science risk	Provides science value within constraints	Unknown VSWIR multi-instrument calibration and validation; may compromise needed uncertainty

Science value

Applications value

Community assessment
 * Best-case

- For Discussion Purposes Only 27