NAC SCIENCE COMMITTEE FALL MEETING

October 8-10, 2024

Designated Federal Officer (DFO) Introduction

Nathan Boll

Executive Secretary

National Aeronautics and Space Administration

NAC Science Committee: Introduction of Members

Amanda Hendrix, Chair

Science Committee Members

- **Amanda Hendrix (Chair), Planetary Science Institute**
- **Noël Bakhtian (Vice Chair), Bezos Earth Fund**
- **Fran Bagenal, University of Colorado Boulder**
- **Paul Cassak, West Virginia University**
  - Chair, Heliophysics Advisory Committee (HPAC)
- **Van Espahbodi, Generational Partners**
- **Jamie Foster, University of Florida**
  - Chair, Biological and Physical Sciences Advisory Committee (BPAC)
- **Linda M. Godwin, University of Missouri**
- **Edward Gonzales, Catholic University of America**
- **Kelly Holley-Bockelmann, Vanderbilt University**
  - Chair, Astrophysics Advisory Committee (APAC)
- **Hope Ishii, University of Hawai‘i at Mānoa**
  - Chair, Planetary Science Advisory Committee (PAC)
- **Tom Soderstrom, Amazon Web Services**
- **Sara Tucker, BAE Systems, Inc.**
  - Chair, Earth Science Advisory Committee (ESAC)

- Executive Secretary: Nathan Boll, NASA HQ

Overview of Agenda

TUESDAY:
NAC Meeting Reports (May, October)
NASA Science Mission Directorate Update
Panel Discussion: NASA IDEA Initiatives and SMD Updates
Panel Discussion: SMD Open Science Initiatives Update
Committee Discussion (90 min)
[note that we do not have public comment/Q&A on agenda until Thurs (10 min)]

WEDNESDAY:
DAC Chair reports
Panel Discussion: Climate Change and Earth System Science Strategy
Panel Discussion: Space Weather Hazard Mitigation and SMD Roles
Committee Discussion (90 min)

THURSDAY:
Public Lecture: OSIRIS-REx
Public Comment Period
Outbrief to NASA SMD

The Science Committee recognizes with gratitude the contributions of following individuals:

Ellen Williams, most recent Chair of Science Committee until April 20, 2024

Noël Bakhtian, Vice Chair, for her service as interim Chair of the NAC Science Committee, April-October 2024.

Outgoing Science Committee Member

- Sara Tucker, BAE Systems, Inc.
  Chair, Earth Science Advisory Committee (ESAC)

The Science Committee also welcomes our newest Members:

- Fran Bagenal, University of Colorado Boulder
- Van Espahbodi, Generational Partners
- Edward Gonzales, Catholic University of America
- Tom Soderstrom, Amazon Web Services

National Aeronautics and Space Administration

NASA Advisory Council Meeting Reports

Amanda Hendrix, Chair

Noël Bakhtian, Vice Chair

Science Committee Report to NAC

Presented by Noël Bakhtian, Vice Chair

1. Science Committee Membership Updates and Recognitions
2. Science Mission Directorate Update and Highlights
3. Science Committee Meeting Summaries (May 2023, August 2023, and March 2024)
4. Findings and Recommendations

See full set of slides in the backup material

NAC Discussion Notes

Presented by Noël Bakhtian, Vice Chair

1. Climate Change
2. Planetary Protection
3. Science Diplomacy and the ISS Transition

Science Committee Report to NAC

Presented by Amanda Hendrix, Chair

1. Science Committee Membership Updates
2. Science Mission Directorate Update and Highlights
    - NISAR (ESD)
    - SEAQUE (BPS)
    - SPHEREx (Astrophysics)
    - ESCAPADE (Heliophysics)
    - Clipper (PSD)
3. Science Committee Fall Meeting Preview (October 8-10, 2024)

NAC Discussion Notes

Presented by Amanda Hendrix, Chair

1. Previous Findings and Recommendations Approved:
    1. Resolutions … approved, transmitted to NASA
    2. Science Mission Directorate (2023) → action to SMD AA
    3. Science Mission Directorate (2024) → action to SMD AA
    4. DAC Reports – Spring Meeting 2023 → action to SMD AA
    5. DAC Reports – Summer Meeting 2023 → action to SMD AA
    6. DAC Reports – Spring Meeting 2024 → action to SMD AA
    7. Earth Science Observatory IRB Report (2023) → action to SMD AA
    8. Tropospheric Emissions: Monitoring Pollution (TEMPO) Mission (2023) → action to SMD AA
    9. Deep Space Network (DSN) (2023) → action to Administrator
    10. Deep Space Network (DSN) (2024) → action to Administrator
    11. Transform to Open Science (TOPS) Program (2023) → action to SMD AA
    12. Inclusion, Diversity, Equity, and Accessibility (IDEA) at SMD (2023) → action to SMD AA +
    13. Broadening SMD Science Impact (2024) → action to SMD AA
    14. NAC Meetings (2024) → action to NAC Exec Dir

Other topics, discussion points at NAC

- Good discussion with Sen Nelson, Col Melroy
  - including their high-level thoughts on NASEM Crossroads report
- NAC Priority Focus Areas
  - International Collaboration
  - DEIA
  - Climate Change
  - Program Management & Acquisitions
- NASA's Summer of AI
- NAC Committees
  - Science
  - Technology, Innovation, Engineering
  - Aeronautics
  - STEM Engagement
  - HEO

slides are posted on the NAC website and we can talk about them here as needed

new Finding proposed at NAC

Finding:

The cancellation of the VIPER mission presents profound impacts on the understanding of lunar volatiles, a key foundation of the Artemis program, and it adversely affects the leadership of the US in lunar exploration.

National Aeronautics and Space Administration

NASA's Vision for Powerful Science

Dr. Nicola "Nicky" Fox
Associate Administrator
Science Mission Directorate
NASA Headquarters

@NASAScienceAA

NASA SCIENCE MISSION DIRECTORATE

OFFICE OF THE ASSOCIATE ADMINISTRATOR (DA000)

ASSOCIATE ADMINISTRATOR
Nicola Fox

DEPUTY ASSOCIATE ADMINISTRATOR
Sandra Connelly

SENIOR ADVISOR
Paul Hertz

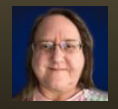
SPACE TRAFFIC COORDINATION PROGRAM OFFICER
Travis Blake

ENGAGEMENT BRANCH (DA070)

DIRECTOR
Amy Kaminski

RESOURCE MANAGEMENT DIVISION (DL000)

DIRECTOR
Holly Degn

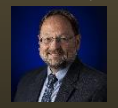


DEPUTY
Kate Wolf

ADMINISTRATION BRANCH (DA030)

CHIEF
Dan Woods
(Acting)

POLICY BRANCH (DA040)



CHIEF
Jens Feeley

DEPUTY
Sara Schwartzman

MANAGEMENT

DEPUTY ASSOCIATE ADMINISTRATOR
Karen Flynn

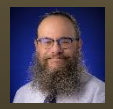
ASSISTANT DEPUTY ASSOCIATE ADMINISTRATOR
Dan Woods

EXPLORATION

DEPUTY ASSOCIATE ADMINISTRATOR
Joel Kearns

ASSISTANT DEPUTY ASSOCIATE ADMINISTRATOR
Brad Bailey

RESEARCH



DEPUTY ASSOCIATE ADMINISTRATOR
Michael New

ASSISTANT DEPUTY ASSOCIATE ADMINISTRATOR
Douglas Hudgins
(Acting)

PROGRAMS

DEPUTY ASSOCIATE ADMINISTRATOR
Peg Luce (Acting)

ASSISTANT DEPUTY ASSOCIATE ADMINISTRATOR
Tahani Amer

MARS SAMPLE RETURN PROGRAM OFFICE (DA050)

DIRECTOR
Jeff Gramling

DEPUTY
Donya Douglas-Bradshaw

DEPUTY-BUSINESS
Rich Ryan

CHIEF ENGINEER
Steve Thibault

CHIEF TECHNOLOGIST
Carolyn Mercer

CONJUNCTION ASSESSMENT PROGRAM OFFICER
Laurie Newman

EARTH SCIENCE DIVISION (DK000)

DIRECTOR
Karen St. Germain

DEPUTY
Julie Robinson

ASSOCIATE DIRECTOR
Scott Schwinger

ASSOCIATE DIRECTOR
Jack Kaye

ASSOCIATE DIRECTOR
Tom Wagner

BIOLOGICAL & PHYSICAL SCIENCES DIVISION (DP000)

DIRECTOR
Lisa Carnell

DEPUTY
Diana Ly

HELIOPHYSICS DIVISION (DJ000)

DIRECTOR
Joe Westlake

DEPUTY
Nicki Rayl
(Acting)

ASSOCIATE DIRECTOR
Bradley Williams
(Acting)

JOINT AGENCY SATELLITE DIVISION (DN000)

DIRECTOR
John Gagosian

DEPUTY
Charles Webb

ASTROPHYSICS DIVISION (DH000)

DIRECTOR
Mark Clampin

ASSOCIATE DIRECTOR
Eric Smith

DEPUTY
Sandra Cauffman

ASSOCIATE DIRECTOR
Joe Smith

PLANETARY SCIENCE DIVISION (DG000)

DIRECTOR
Gina DiBraccio
(Acting)

DEPUTY
Eric Ianson

ASSOCIATE DIRECTOR
Shannon Fitzpatrick

CHIEF MARS SCIENTIST
Lindsay Hays

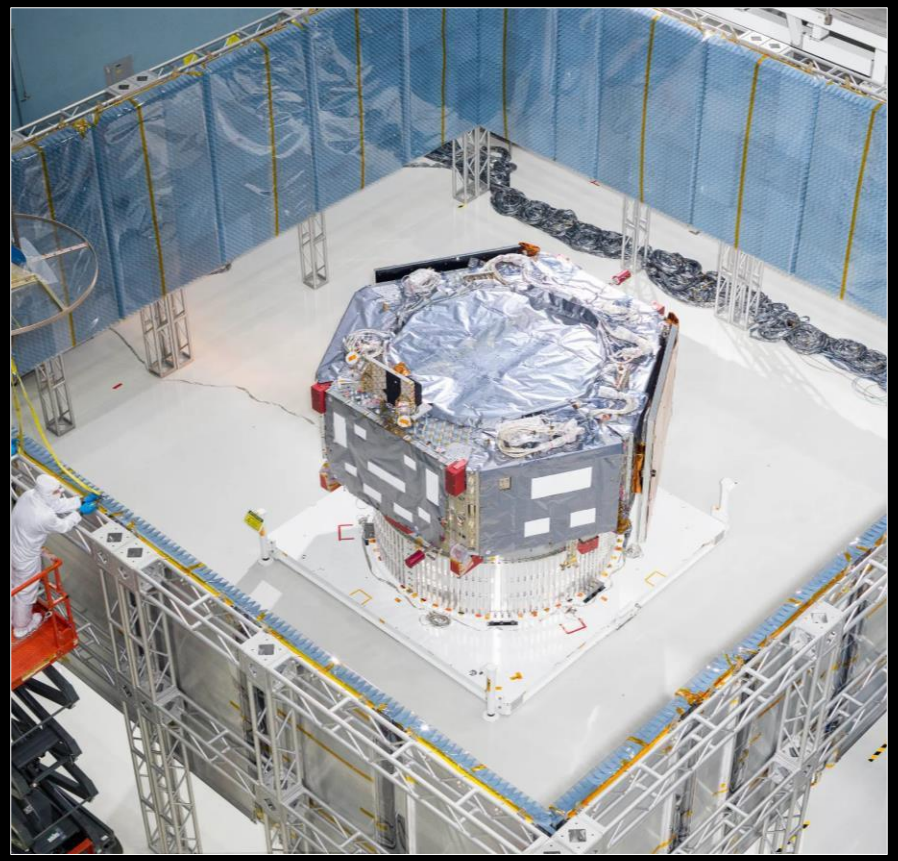
CHIEF SCIENCE DATA OFFICER
Kevin Murphy

9-12-24

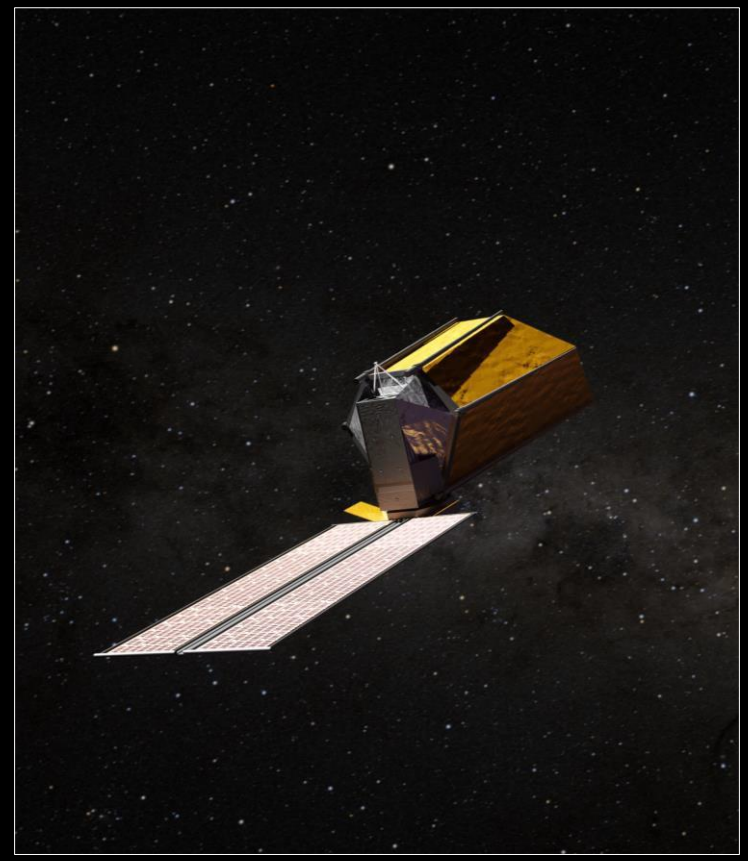
SMD CROSSCUTTING UPDATES

DIVISION UPDATES

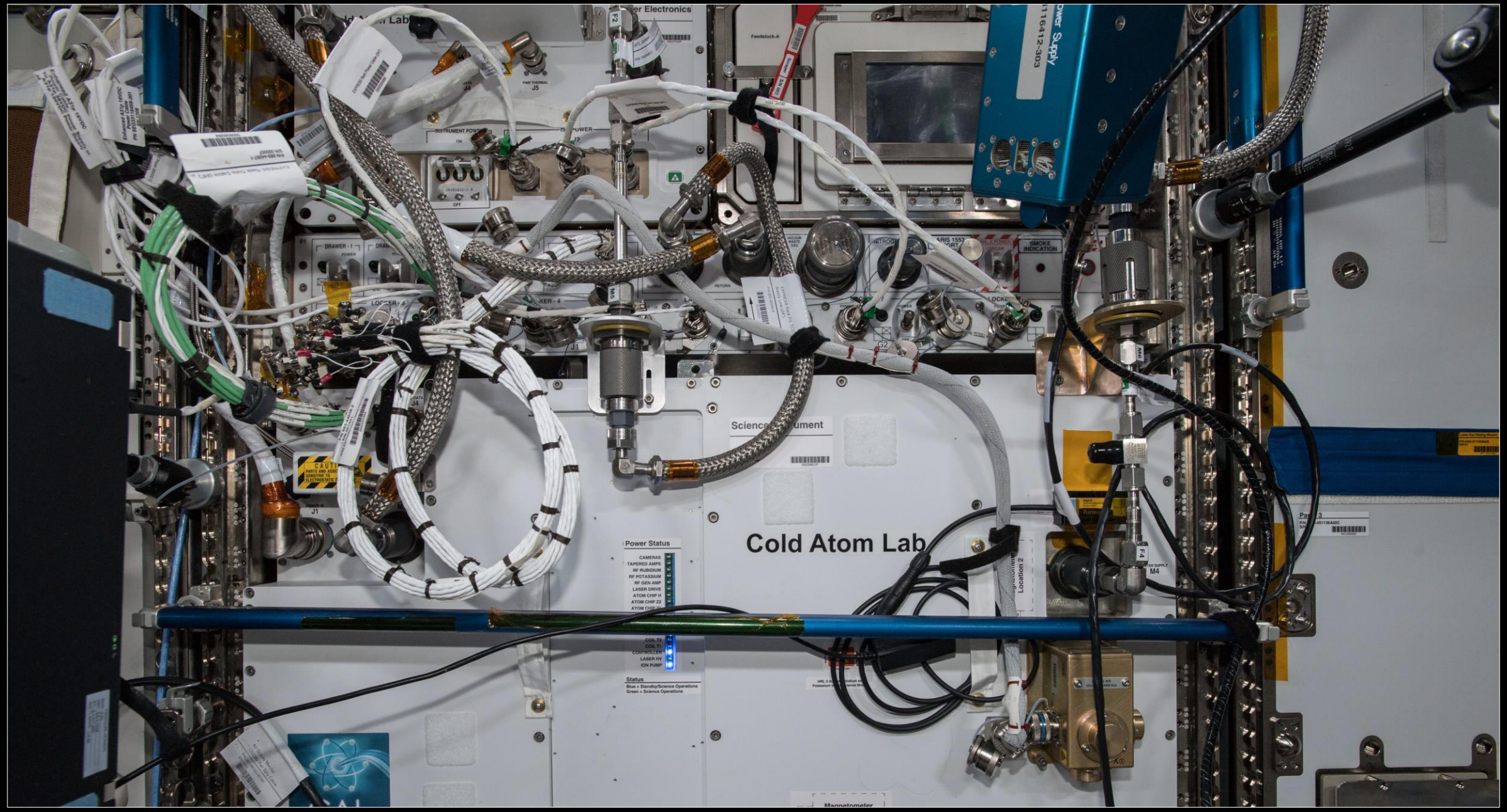
SPHEREx Observatory Assembled



Nancy Grace Roman Space Telescope's spacecraft bus

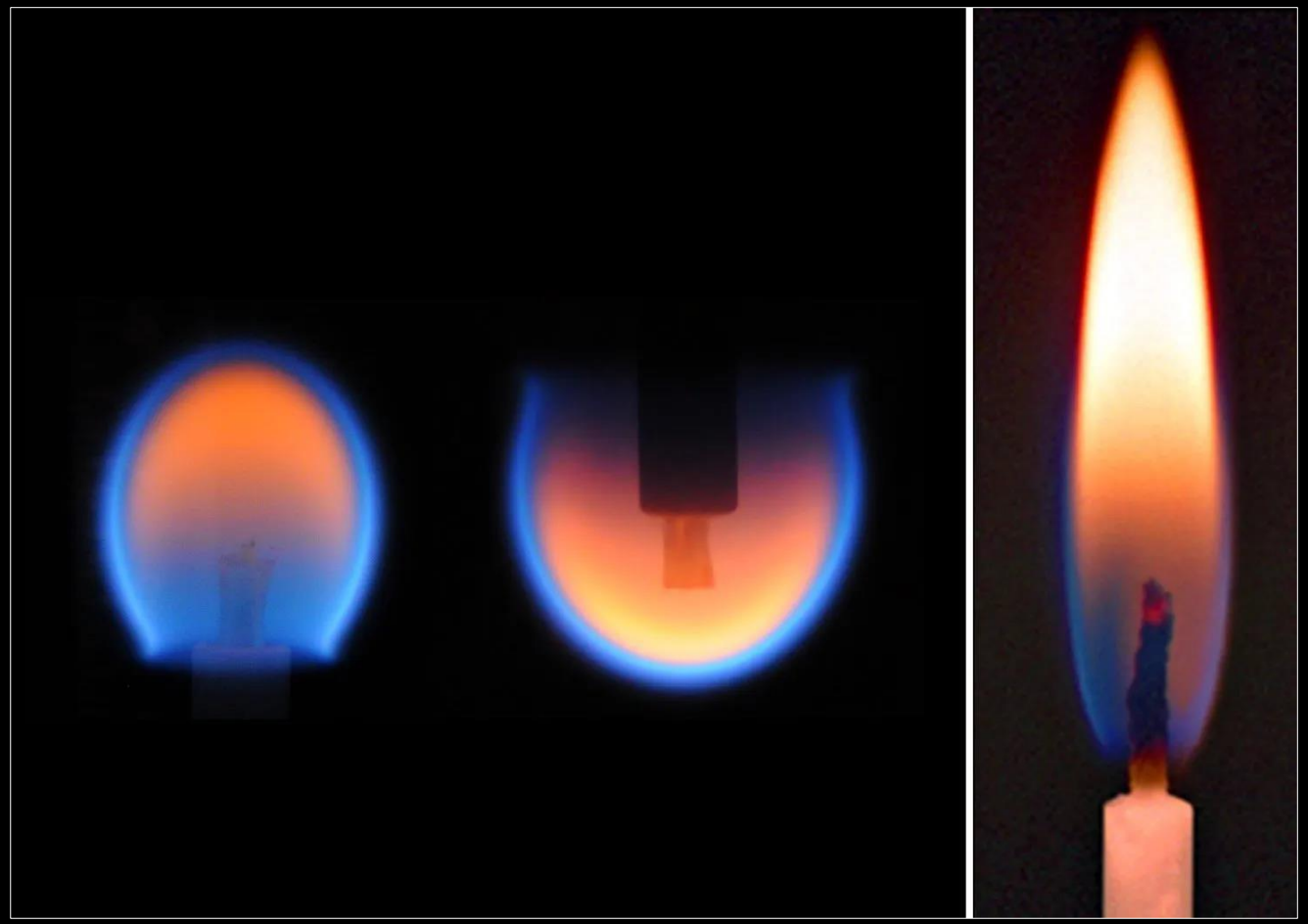


Artist's concept still of the Habitable Worlds Observatory

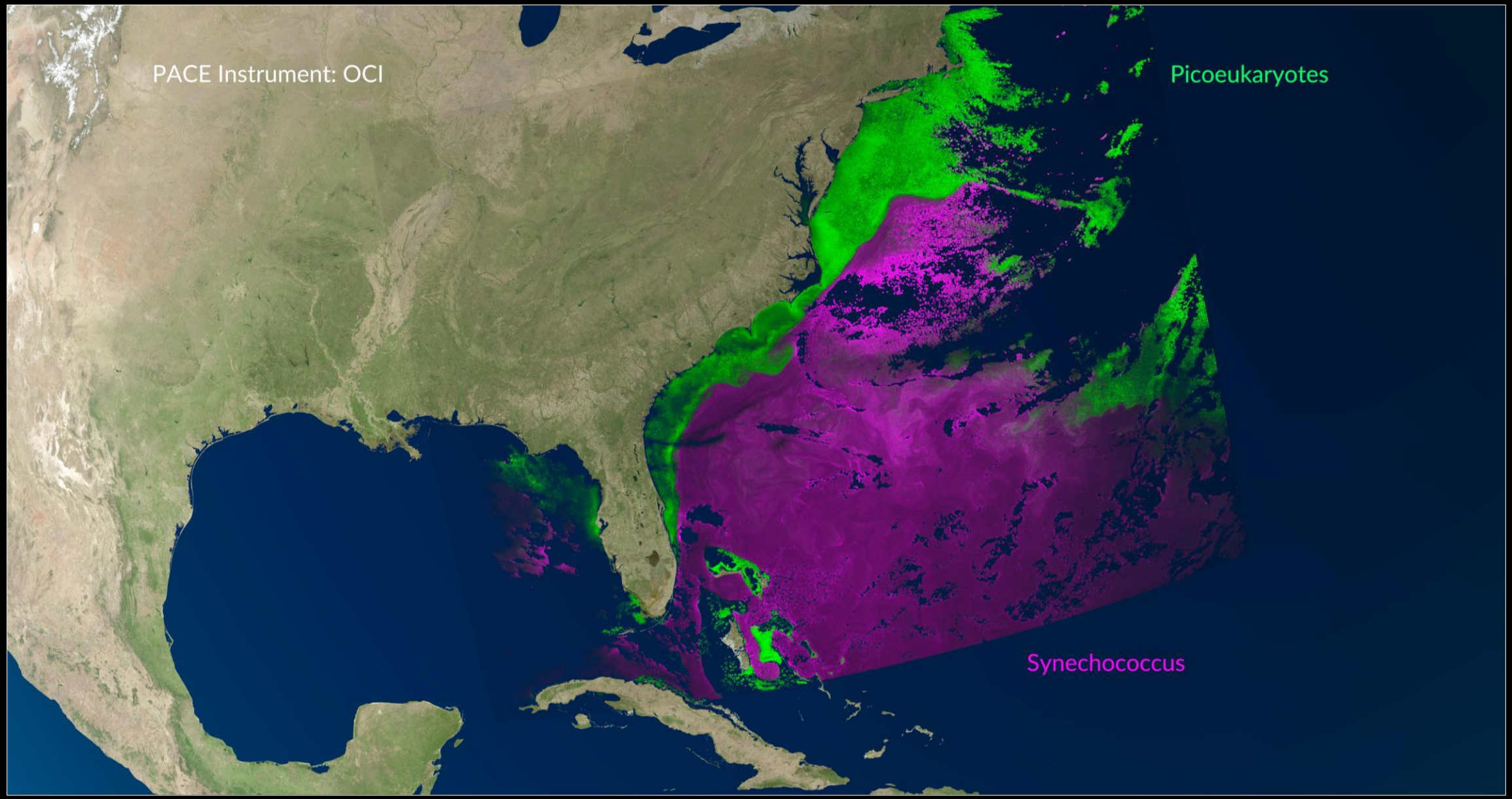

Cold Atom Lab
Power Status
Status
SMOKE INDICATION


SPORT
BLUE ORIGIN

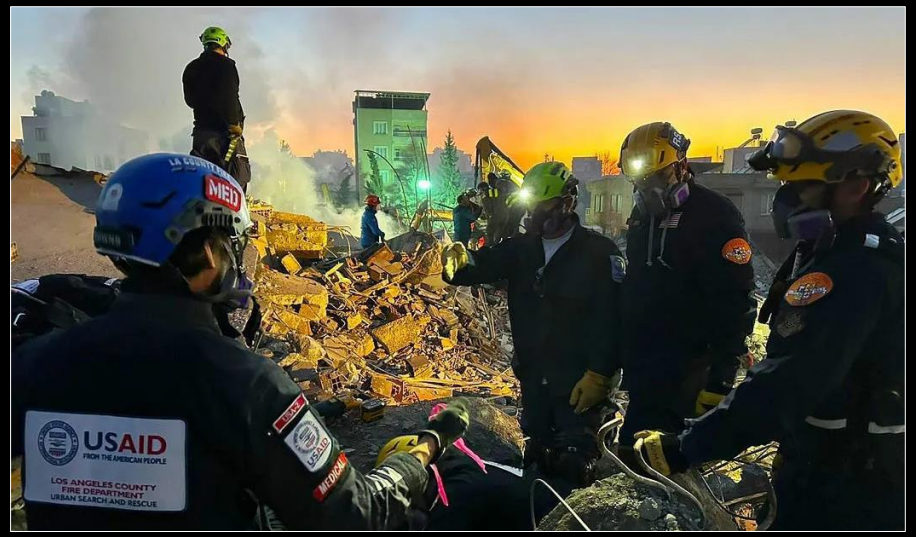
Tissue chip experiment

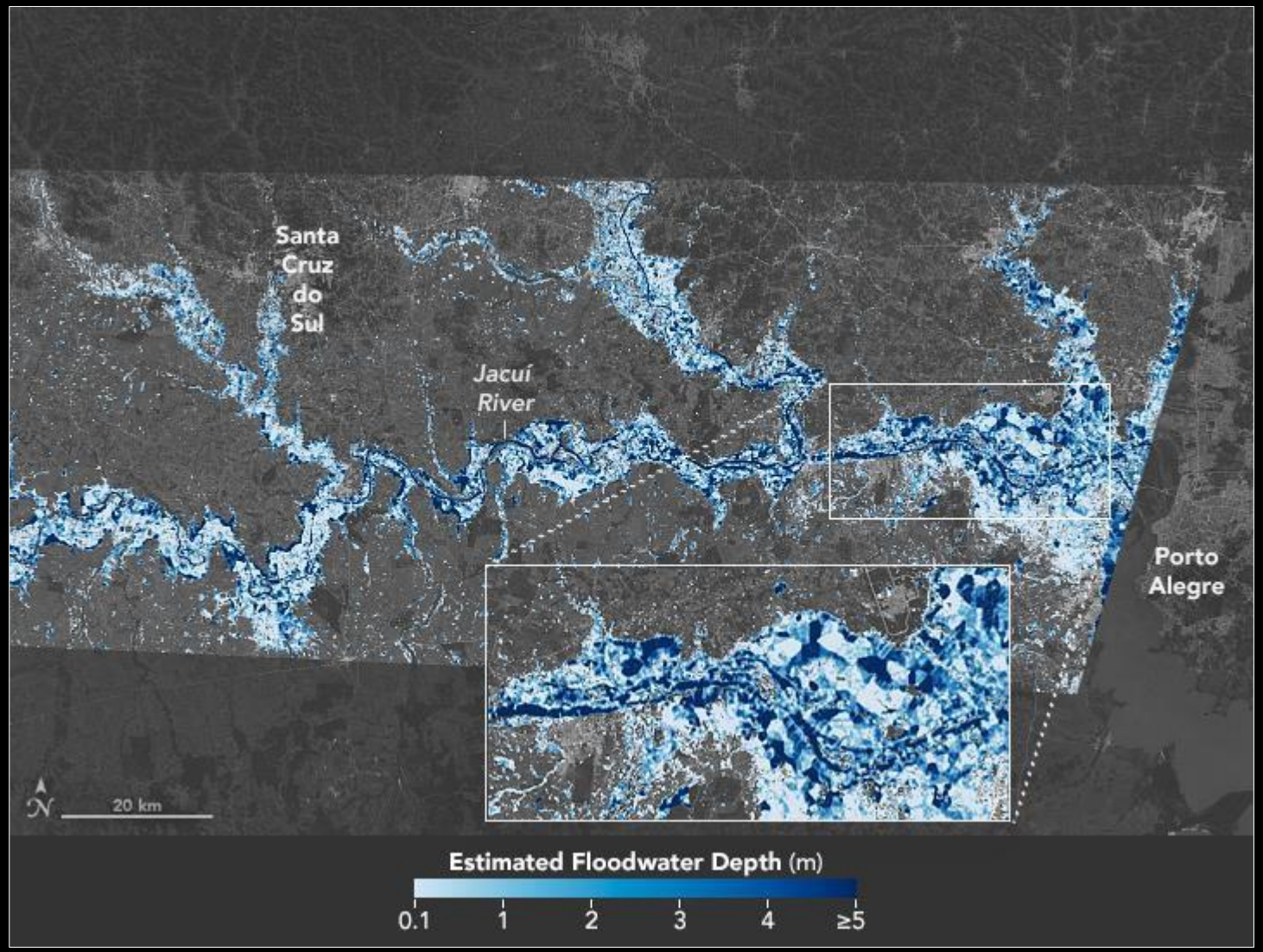


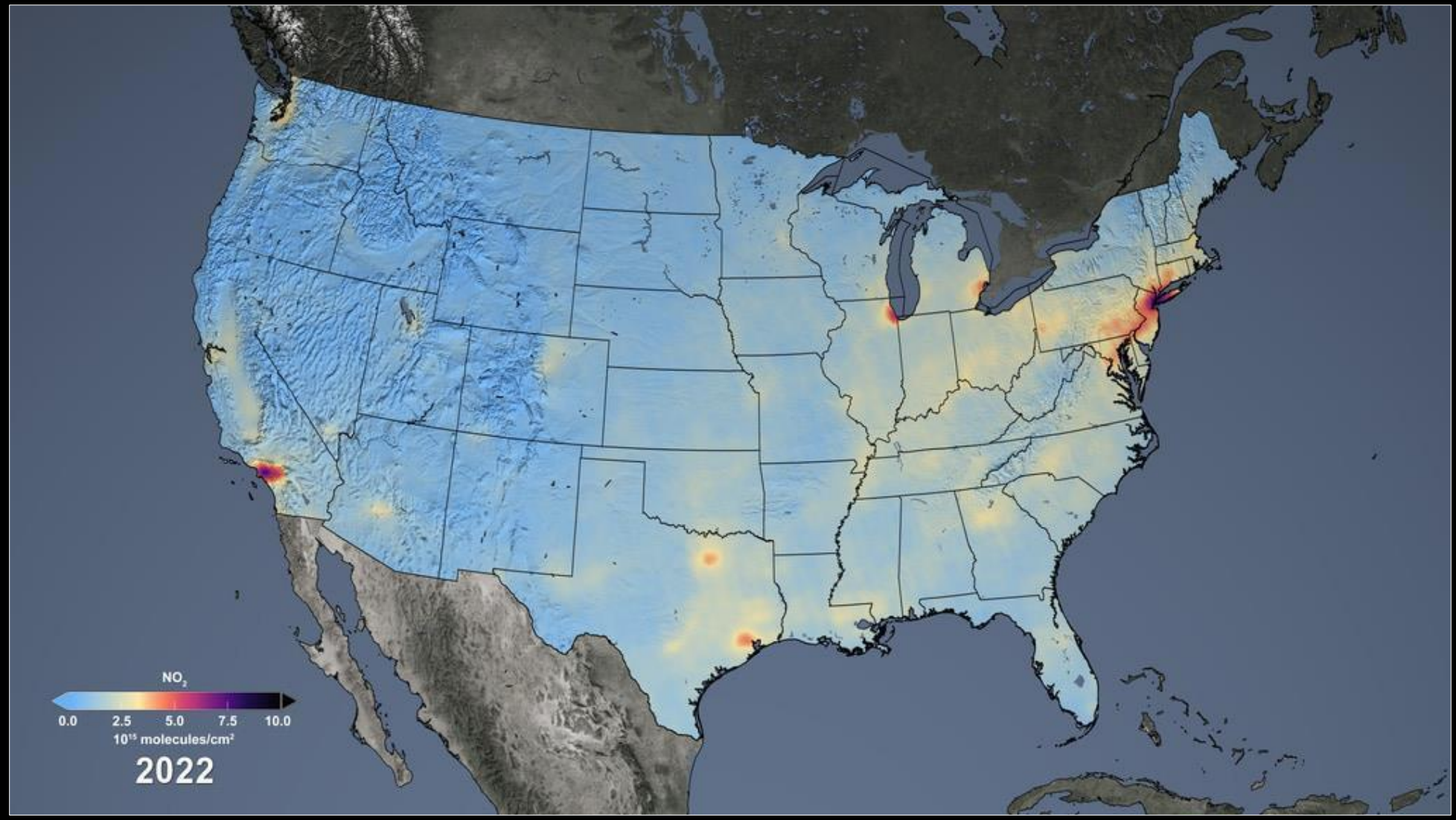
A spherical flame created in space (left), and a candle flame burning on Earth (right)



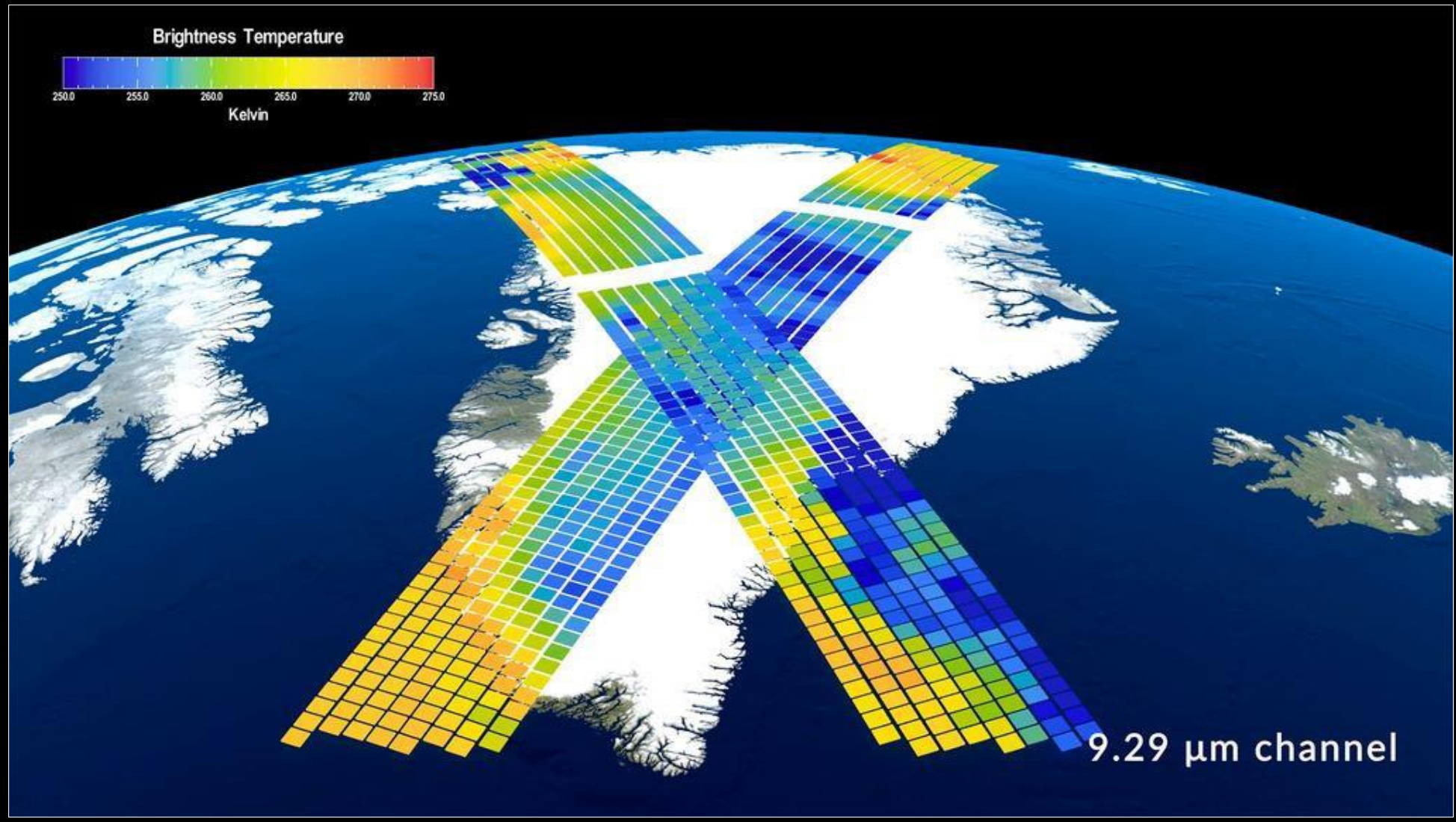
False color data visualization of phytoplankton (Picoeukaryotes and Synechococcus), as observed by PACE's OCI instrument.


USAID
FROM THE AMERICAN PEOPLE
LOS ANGELES COUNTY
FIRE DEPARTMENT
URBAN SEARCH AND RESCUE
MED

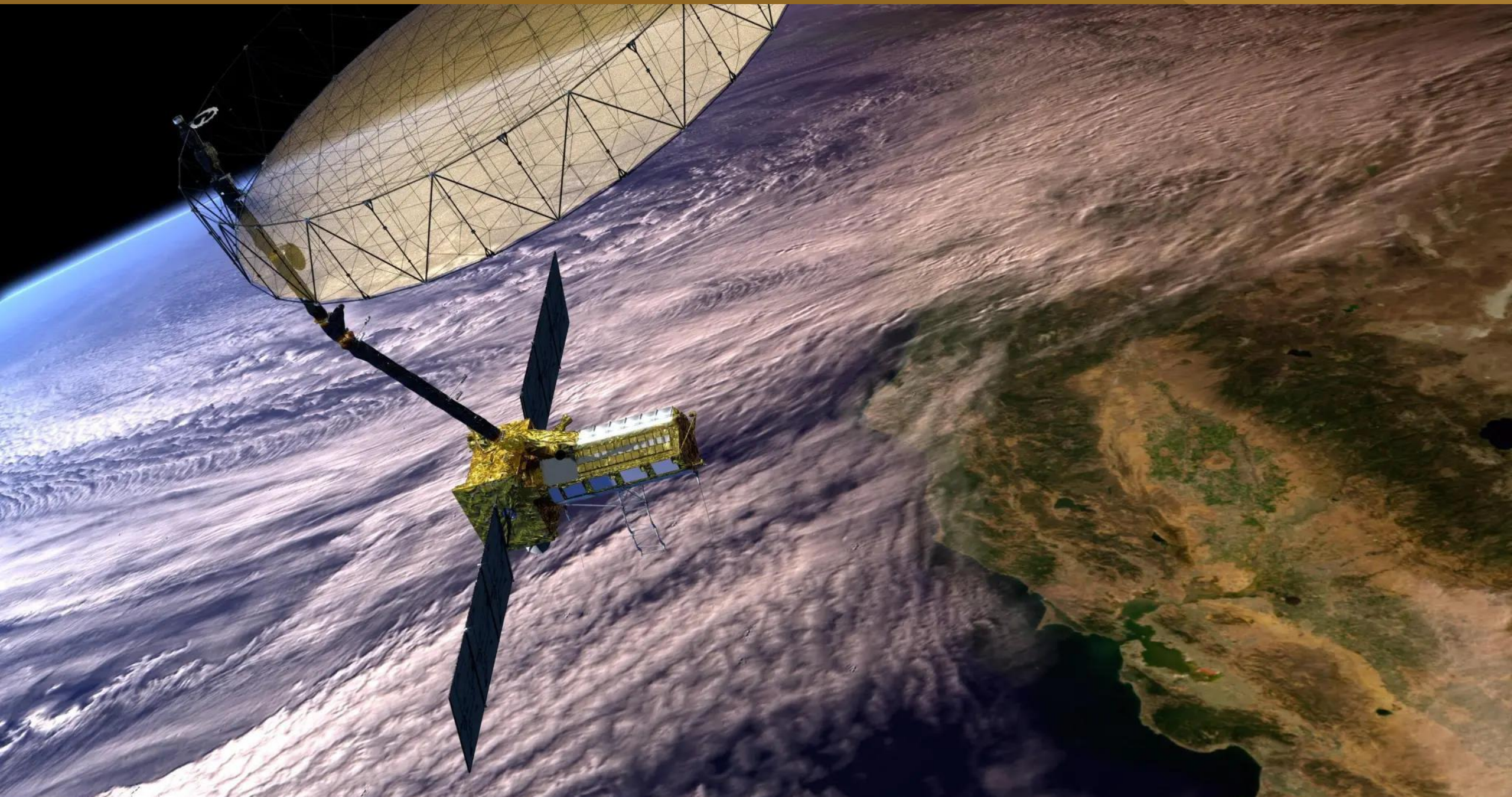

Santa Cruz do Sul
Jacuí River
Porto Alegre
20 km
Estimated Floodwater Depth (m)
0.1
1
2
3
4
≥5

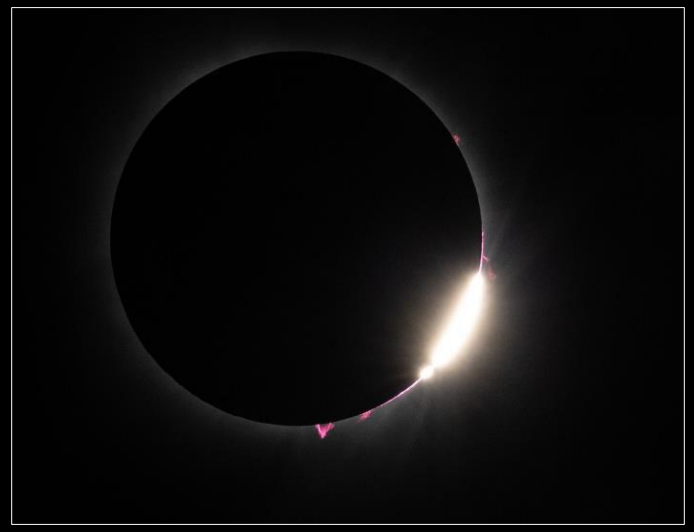


Average concentrations of NO2 for 2022 over the U.S., as detected by the Ozone Monitoring Instrument on NASA's Aura satellite.



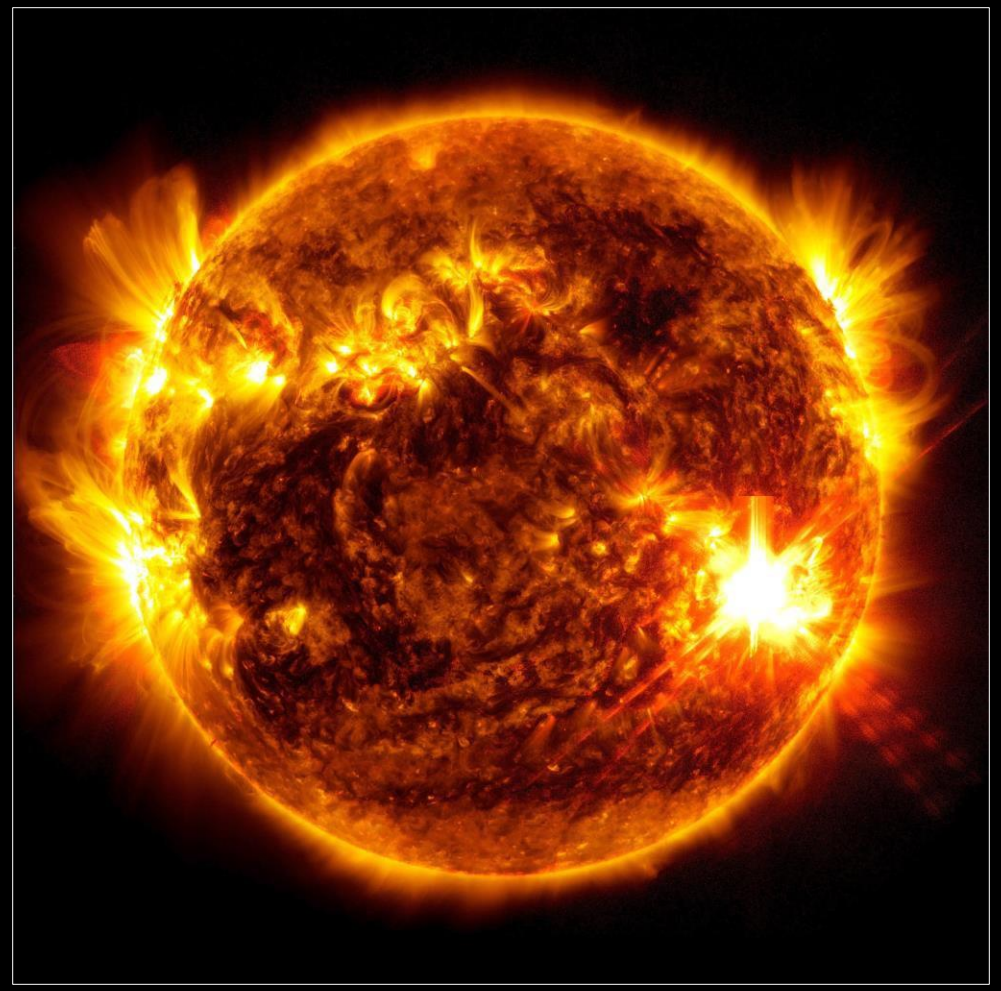
From a still frame of the PREFIRE first light video, showing a visualization of some PREFIRE-SAT2 data captured in July 2024.

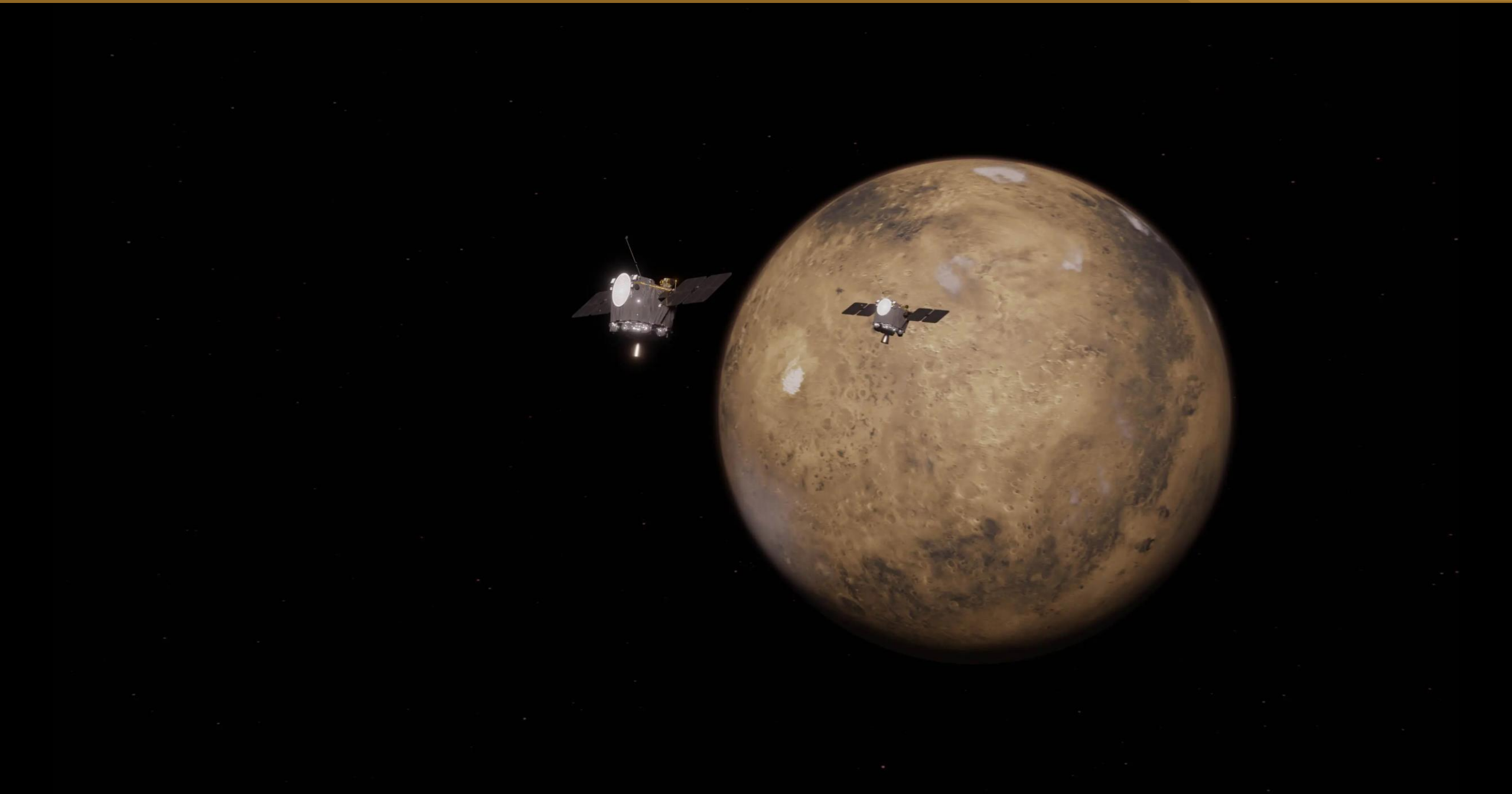




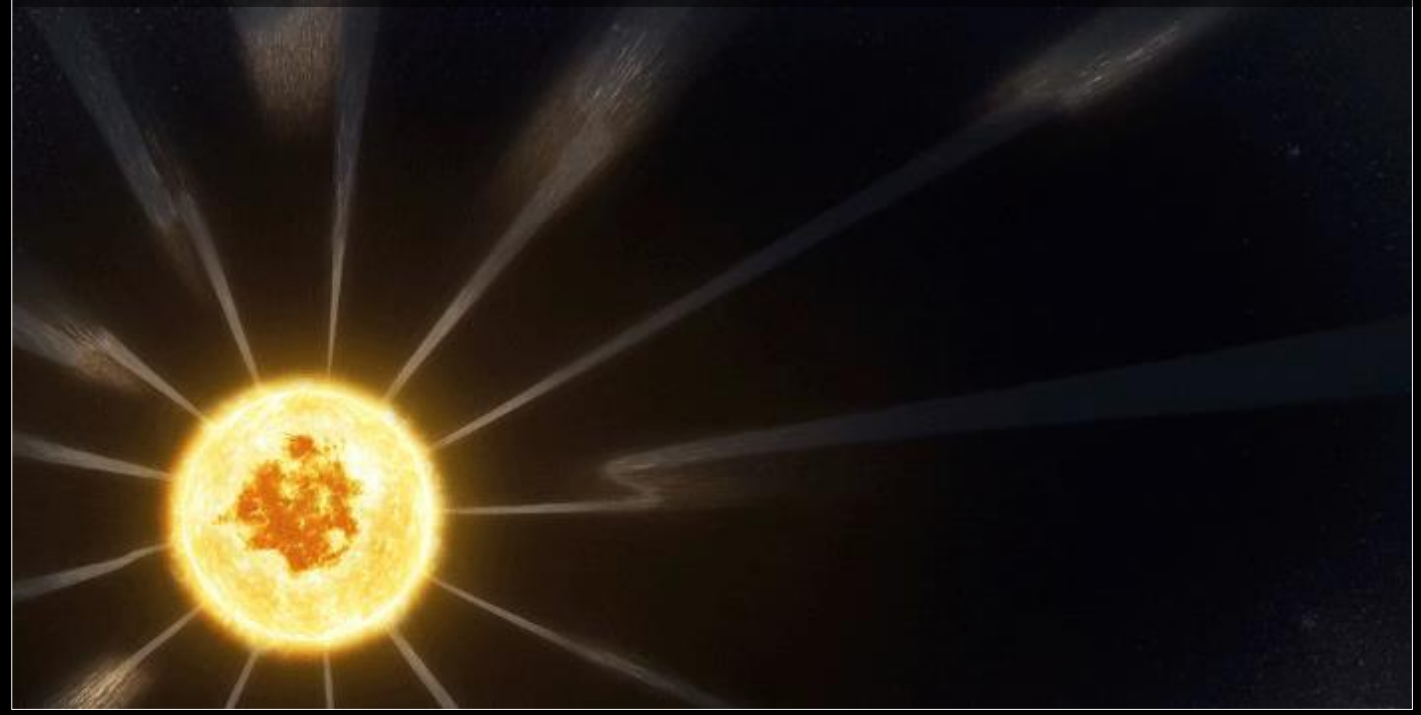

Glenn Research Center
Lewis Field


14 x 30 x 1
NANCY GRACE ROMAN

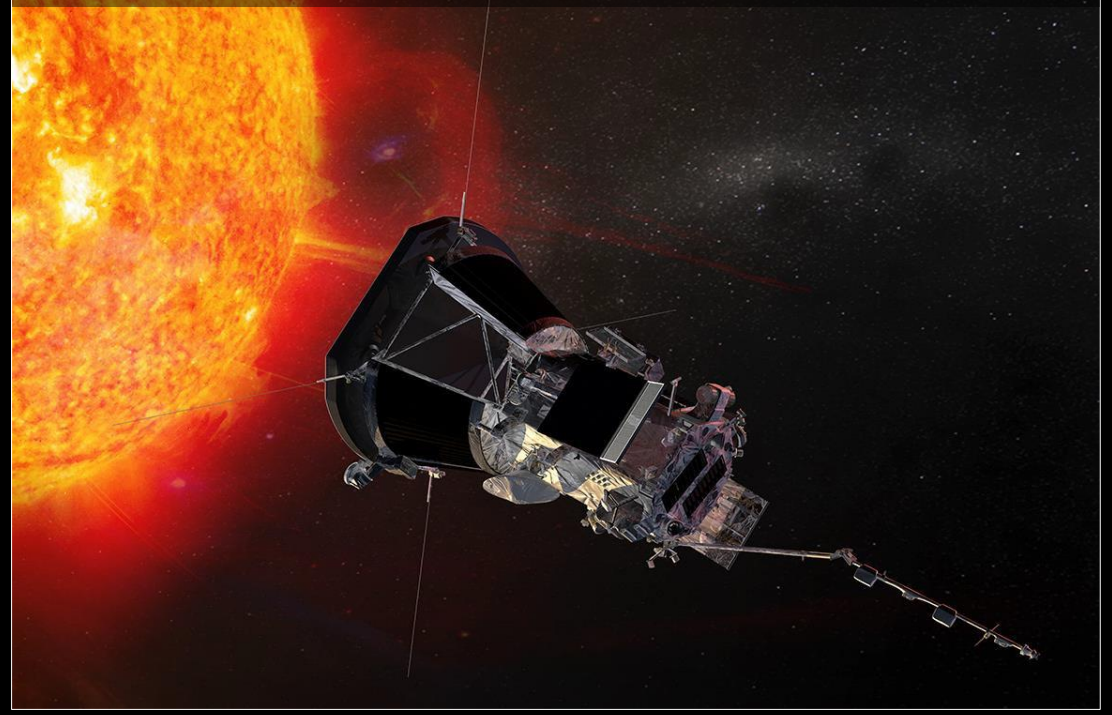




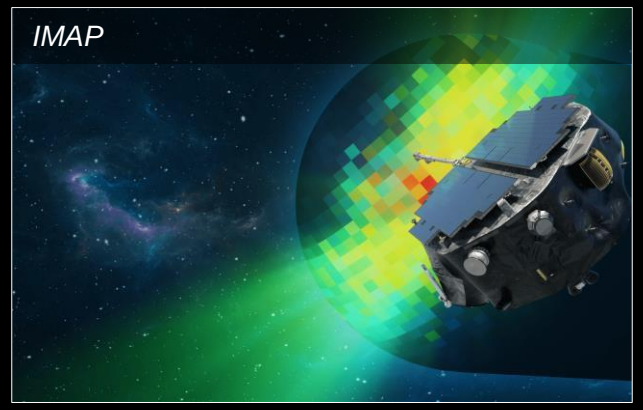
Artist's conception of switchbacks, or large kinks in the Sun's magnetic field.



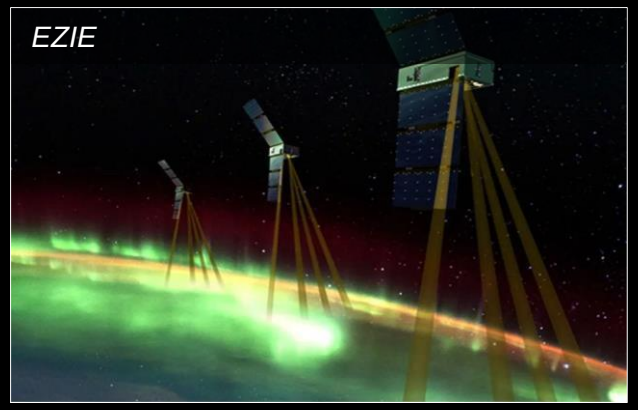
Artist's illustration of Parker Solar Probe



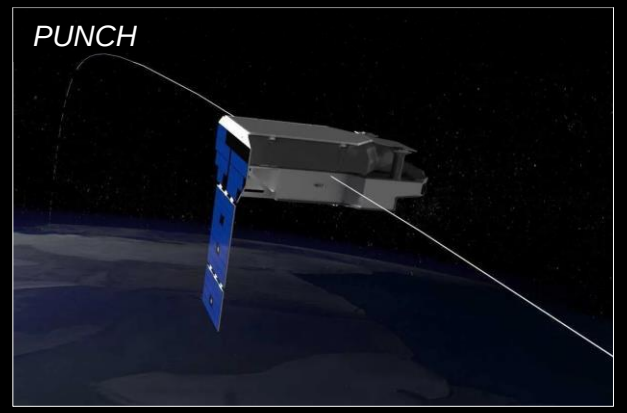
IMAP



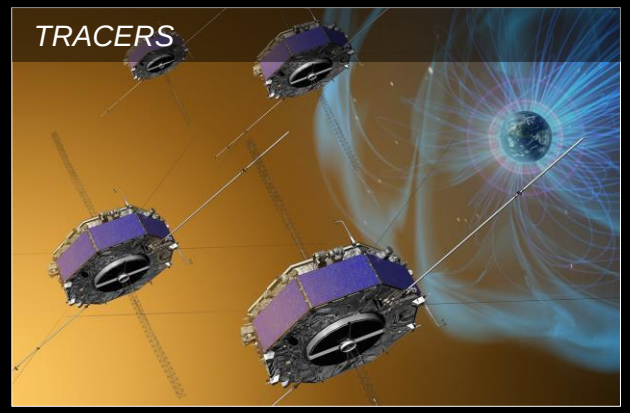
EZIE



PUNCH



TRACERS



NEO Surveyor

Europa Clipper

The Lunar Environment Monitoring Station (LEMS)

A compact, autonomous seismometer suite designed to carry out continuous, long-term monitoring of the seismic environment, namely ground motion from moonquakes, in the lunar south polar region.

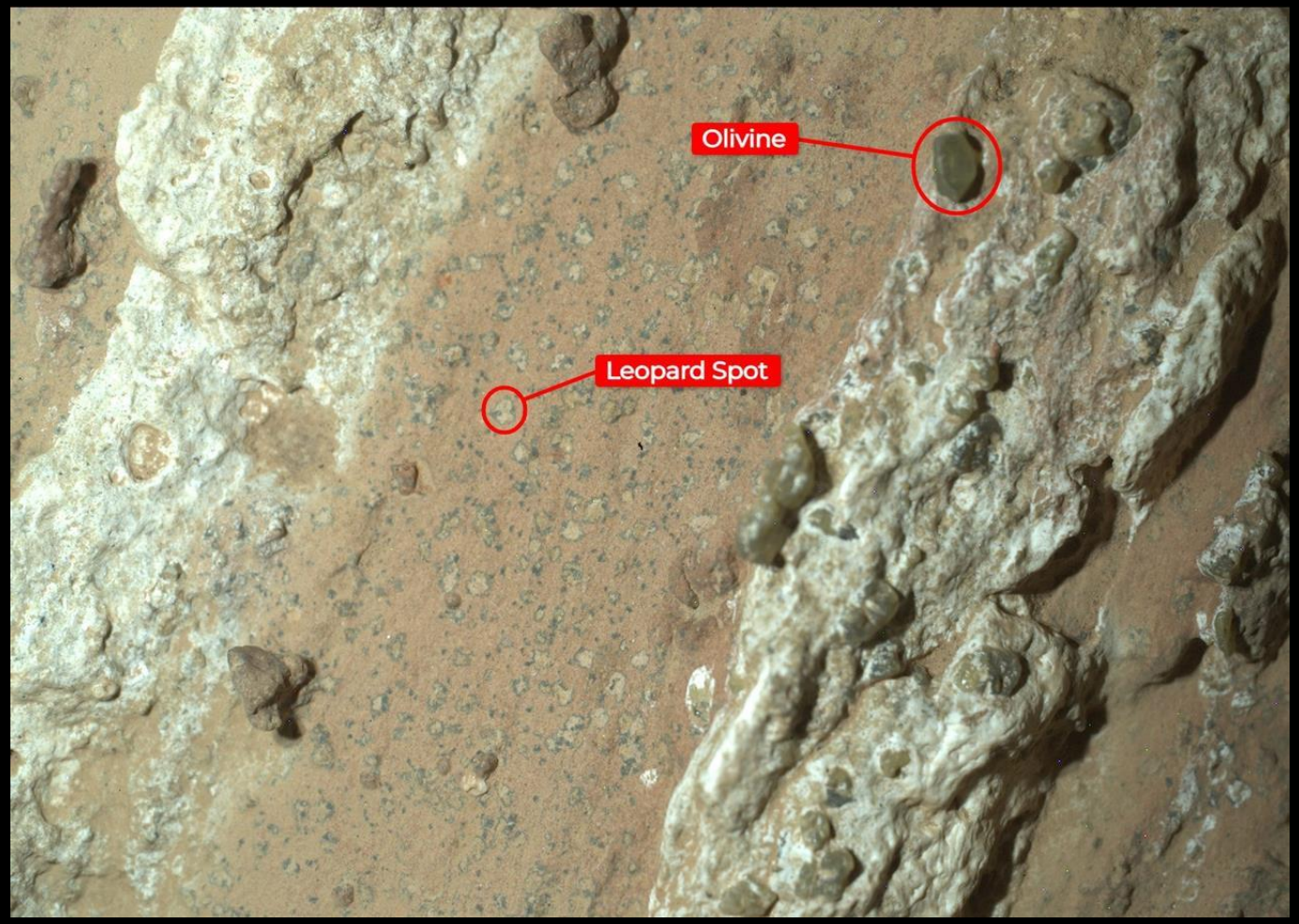
Lunar Effects on Agricultural Flora (LEAF)

LEAF will investigate the lunar surface environment's effects on space crops. LEAF will be the first experiment to observe plant photosynthesis, growth, and systemic stress responses in space-radiation and partial gravity.

The Lunar Dielectric Analyzer (LDA)

LDA will measure the regolith's ability to propagate an electric field, which is a key parameter in the search for lunar volatiles, especially ice. It will gather essential information about the structure of the Moon's subsurface, monitor dielectric changes caused by the changing angle of the Sun as the Moon rotates, and look for possible frost formation or ice deposits.


INTUITIVE
MACHINES


Olivine
Leopard Spot


METEORITES
Rocks from Space
Why study meteorites?
Antarctic Meteorite Curation Facility


Thank you!

BREAK

Committee will reconvene at 1pm ET

National Aeronautics and Space Administration

Discussion Panel: NASA IDEA Initiatives and SMD Updates

Elaine Ho, Associate Administrator, Office of Diversity and Equal Opportunity

Michael New, Deputy Associate Administrator for Research, NASA SMD

NAC Science Committee

Elaine Ho, Associate Administrator, ODEO

October 2024

DEIA is critical to our mission, teams and partners

Mission

Fostering an inclusive culture that leverages diversity of thought, backgrounds, & perspectives sparks innovation and creativity that are critical to our safety culture & mission success.

Teams

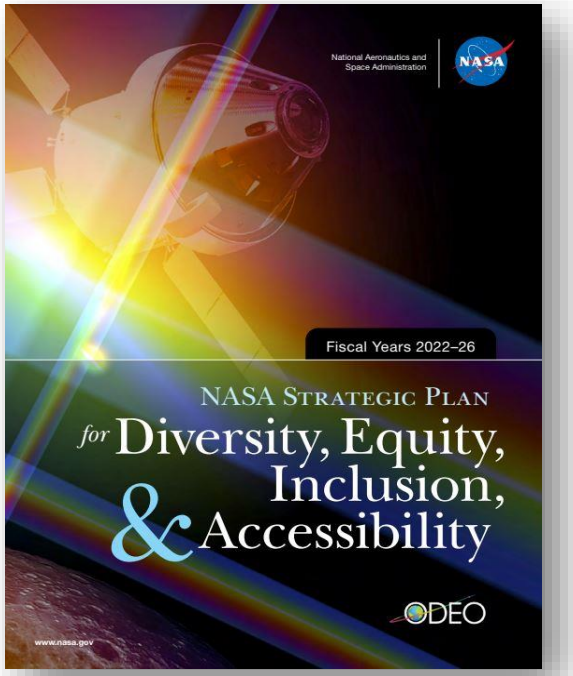
Empowering and engaging diverse teams where each member feels valued, trusted and a sense of belonging allows each of us to raise safety concerns & bring our best selves each day to the mission.

Partners

Having a diverse workforce that reflects & understands our partners and stakeholders allows NASA to effectively explore the universe for the benefit of humanity.

NASA Strategic Plan for DEIA

Strategic Goals



The NASA Strategic Plan for DEIA provides a roadmap for how we can move forward together towards achieving our common goal: advancing DEIA for the benefit and safety of our workforce.

1 Workforce Diversity

2 Workforce Equity and Inclusion

3 Accessibility and Accommodation

4 DEIA Integration into the NASA Mission

NASA Strategic Plan for DEIA

Strategic Goals

1. **Workforce Diversity**
2. **Workforce Equity and Inclusion**
3. **Accessibility and Accommodation**
4. **DEIA Integration into the NASA Mission**

Strategic Goal 1

Recruit, hire, and retain a diverse group of employees to secure a high-performing workforce drawn from all segments of American society

Intended Outcome

Greater employee diversity across the entire employment lifecycle (e.g., recruitment, hiring, promotions, retention), including increased representation of underrepresented individuals and underserved communities

NASA Strategic Plan for DEIA

Strategic Goals

1. **Workforce Diversity**
2. **Workforce Equity and Inclusion**
3. **Accessibility and Accommodation**
4. **DEIA Integration into the NASA Mission**

Strategic Goal 2

Cultivate a work environment that encourages collaboration, flexibility, impartiality, and fairness to enable individuals to contribute to their full potential and further retention

Intended Outcome

Positive employee viewpoints on the work environment (e.g., fairness, openness, cooperation, support, and engagement) indicated on surveys such as the FEVS

NASA Strategic Plan for DEIA

Strategic Goals

1. **Workforce Diversity**
2. **Workforce Equity and Inclusion**
3. **Accessibility and Accommodation**
4. **DEIA Integration into the NASA Mission**

Strategic Goal 3

Design, construct, develop, and maintain facilities, technology, programs, and services so that all people, including people with disabilities and of all religions, can fully and independently use them

Intended Outcome

Continuous improvement to ensure full accessibility and provide timely and effective accommodations to advance equity for all employees.

NASA Strategic Plan for DEIA

Strategic Goals

1. **Workforce Diversity**
2. **Workforce Equity and Inclusion**
3. **Accessibility and Accommodation**
4. **DEIA Integration into the NASA Mission**

Strategic Goal 4

Implement structures and strategies to equip leaders with the ability to manage diversity, be accountable, measure results, refine approaches based on data, and institutionalize a culture of inclusion.

Intended Outcome

NASA integrates DEIA into its decision-making, governance, mission, and goals.

NASA Science Missions

COUNTDOWN TO LAUNCH (EASTERN TIME)

Europa Clipper
Target: October 10, 2024

00:00:05:19:53:38
YRS MOS DAYS HRS MINS SECS

"Draw-a-Scientist" Test

David Wade Chambers, Social Studies of Science, Deakin University, Victoria, Australia 1983
David Miller, *A Meta Analysis of 5 Decades of U.S. DAST Studies, 2018*

1966 - 1977

Of the almost 5,000 drawings produced within the study, just 28 depicted a female scientist, and all of those were drawn by girls.

Not a single boy drew a woman.

"Draw-a-Scientist" Test

David Wade Chambers, Social Studies of Science, Deakin University, Victoria, Australia 1983
David Miller, *A Meta Analysis of 5 Decades of U.S. DAST Studies, 2018*

1985 - 2016

28 percent of children drew a female scientist, on average. In addition, both girls and boys drew female scientists more often over time, though girls overall drew female scientists much more often than boys.

During elementary and middle school, the tendency to draw male scientists increased strongly with age. Older children were also more likely to draw scientists with lab coats and glasses, suggesting that children learn other stereotypes as they mature.

Dr. Nicola "Nicky" Fox

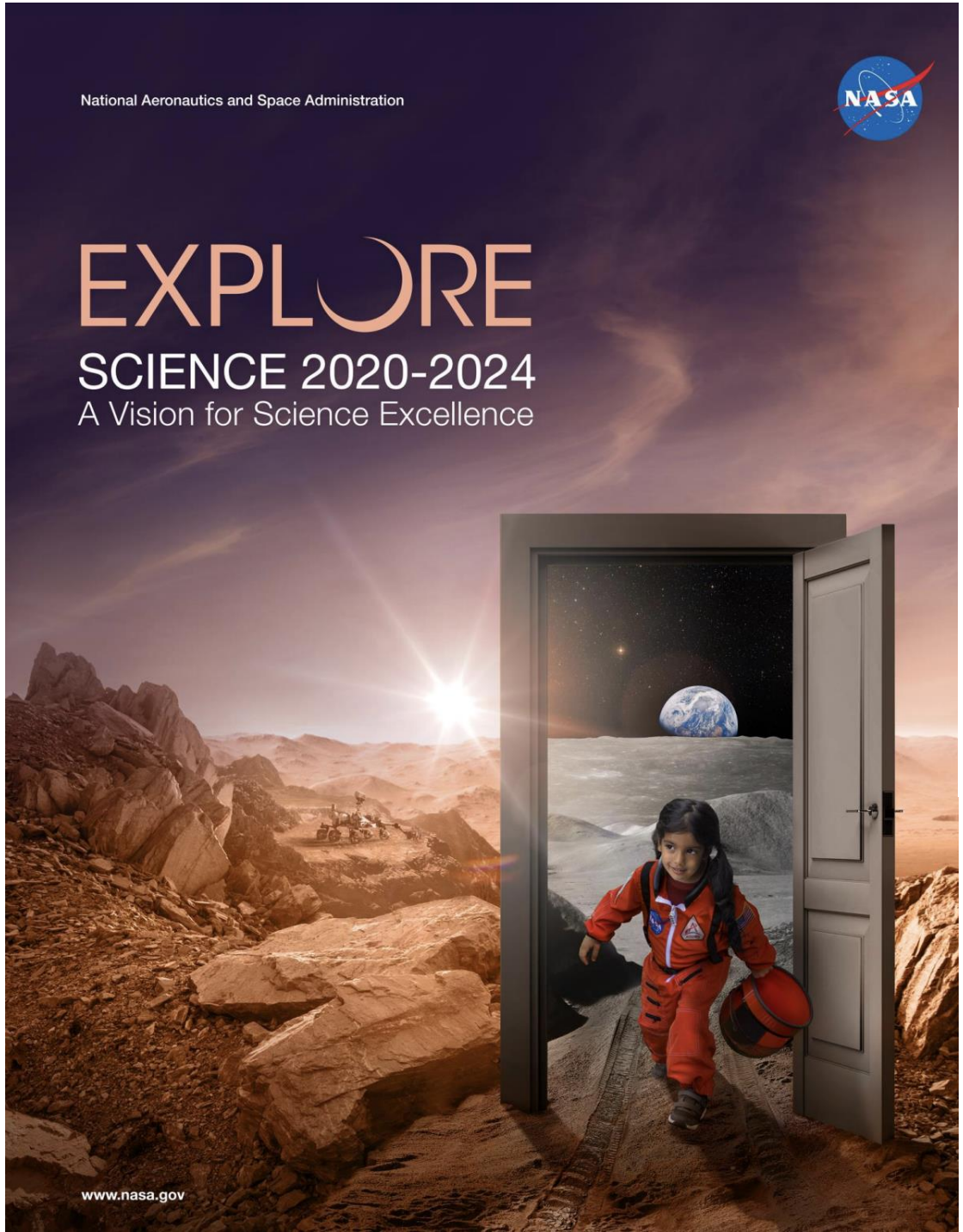
Associate Administrator,
NASA Science Mission
Directorate

Dr. Makenzie Lystrup

Center Director,
Goddard Space Flight Center

Dr. Laurie Leshin

Center Director,
Jet Propulsion Laboratory



PRIORITY 4
INSPIRATION

STRATEGY 4.1: Increase the diversity of thought and backgrounds represented across the entire SMD portfolio through a more inclusive environment.

STRATEGY 4.2: Purposefully and actively engage with audiences and learners of all ages to share the story of NASA's integrated science program.

National Aeronautics and Space Administration

NASA

2024 NASA SCIENCE

IDEA Activities Update for Science Committee

Michael H. New, PhD
Deputy Associate Administrator, Research
@drspacebuzzkill

Pertinent NASEM Reports

The National Academies conducted two *ad hoc* studies at SMD's request:

- Foundations of a Healthy and Vital Research Community for NASA Science (2022)
- Advancing Diversity, Equity, Inclusion, and Accessibility in the Leadership of Competed Space Missions (2022)

Combined, these two studies made 33 recommendations, 6 of which (3+3) were essentially the same.

Several of the recommendations were at least partially implemented at the time of publication or have been implemented since release of the reports.

Some of the recommendations could not be addressed by SMD alone.

Recommendations Implemented

A requirement for AO proposals to include an “Inclusion Plan” is now standard for AOs. These plans are evaluated by inclusion practitioners and researchers and the evaluation results are included in the evaluation of the Merit of the Scientific Implementation (Form B).

SMD has published research on the diversity of Astrophysics Explorer proposals *(Leadership and Participation in NASA's Explorer-Class Missions, https://arxiv.org/abs/1909.10314v1)* and will release a similar analysis of all AO proposals in 2025.

The MOSAICS and Research Initiation programs explicitly target non-R1 institutions (including HBCUs, other MSIs, PUIs, Tribal Colleges, and community colleges).

- MOSAICS funds the creation and implementation of sustainable and deep collaborations between faculty, their students, and NASA researchers.
- Research Initiation Awards provide two years of funding for faculty at non-R1 institutions to start a research program involving their students,

Recommendations Implemented (2)

SMD is collecting metrics of participation in its research programs and making aggregated data available to the community *via* annual SMD Research and Analysis Program Yearbooks (https://science.nasa.gov/roses2021yearbook/)

> The Yearbook contains both institutional information as well as demographic information of proposal PIs and science team members.

SMD has developed IDEA Strategic Plans, including measures of success, that have been published and executed for several years.

SMD has assigned responsibility for overseeing the collection and analysis of data used to determine how well SMD is doing in creating a vibrant and healthy science community and the degree to which they are meeting diversity, equity, inclusion, and accessibility (DEIA) goals to the Deputy Associate Administrator for Research, a Senior Executive Service position.

Recommendations SMD cannot implement on its own

"NASA should empanel an ongoing NASA Advisory Council (NAC) committee specifically focused on diversity, equity, inclusion, and accessibility (DEIA), whose committee chair serves directly on the NAC. This committee should have a broad charter and external world-class membership in this area to directly advise top NASA leadership and ensure an ongoing strong focus on NASA's broadening DEIA efforts."

> *SMD cannot create a committee of the NAC. This committee could, of course, recommend the creation of a new committee to the full NAC for discussion.*

"Working with experts in demographics data gathering and analysis, NASA should review, update and expand the NSPIRES Personal Profile questions and regularly encourage proposers to update their responses."

> *The Personal Profile questions are limited by the OMB's current policies and any change will require the approval of the OMB. Until the OMB changes it's allowed demographic questions, NASA cannot not update its questions. NASA has, in the past, requested changes to the demographic questions — especially regarding gender identity — from the OMB without gaining its approval.*

Through the Eyes of NASA

BREAK

Committee will reconvene at 2:30pm ET

National Aeronautics and Space Administration

Discussion Panel: SMD Open Science Initiatives Update

Kevin Murphy, Chief Science Data Officer, NASA SMD

Chelle Gentemann, Open Science Program Scientist, NASA SMD

OCSDO
OFFICE OF THE CHIEF
SCIENCE DATA OFFICER

NASA

NASA Advisory Council Science Committee 2024

Kevin Murphy, Chief Science Data Officer
Chelle Gentemann, Open Science Program Scientist

OCSDO
OFFICE OF THE CHIEF
SCIENCE DATA OFFICER

The OCSDO advances NASA's unique science missions and enable groundbreaking discoveries by supporting innovative open data science and expanding the accessibility of scientific information.

Core Data and Computing Services

Continuously evolve data and computing systems for efficiency, sustainability, security, and scientific integrity.

Data Science and Innovation

Develop and implement capabilities to enable open science practices and the use of innovative data science techniques.

Open Science Implementation

Enable scientific communities in adopting an inclusive culture of open science and foster partnerships for innovation.

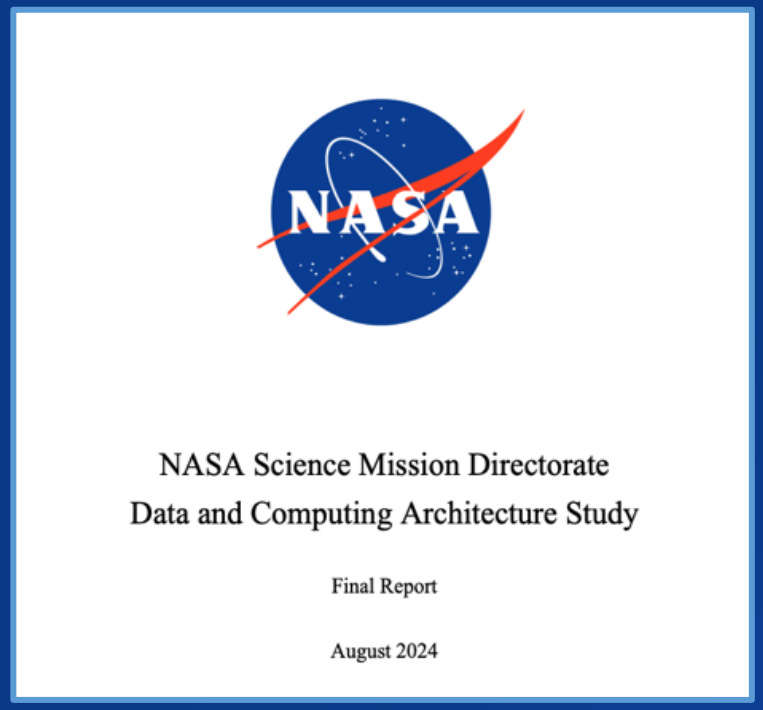
Core Data and Computing Services Goals

Provide an accessible scientific data and computing capabilities to support an inclusive and efficient scientific process within SMD

Provide a unified infrastructure to all SMD Divisions to make interdisciplinary science easier and faster

Enable innovation, infusion, and user experience improvements faster and more uniformly so that all can benefit

Data and Computing Architecture Study



The study examined how to best ensure long-term sustainability for NASA's data and computing infrastructure to support open-source science access to advanced computing, collaboration, cybersecurity management and balancing costs.

Services provided by Divisions to support unique needs of Division user communities

User Interface Services
User interface services for person and machine-to-machine access and use of analysis services

Analysis Services
Analysis services that are accessed by the user interface services to support Open-Source Science

Data Services
Data access and management services that support the analysis services

Core Data and Computing Services deployed in collaboration with Divisions

IT Support Services
IT support services for developing and running the user interface, analysis, data, and support services

Cloud and Infrastructure Services
Infrastructure services with interoperable access to other agency infrastructure services (e.g. computing, networking, communication, etc.) to host/provision the user interface, analysis, data, and IT support services

Data Science and Innovation Goals

Develop a comprehensive strategy for driving innovative data science and AI/ML initiatives

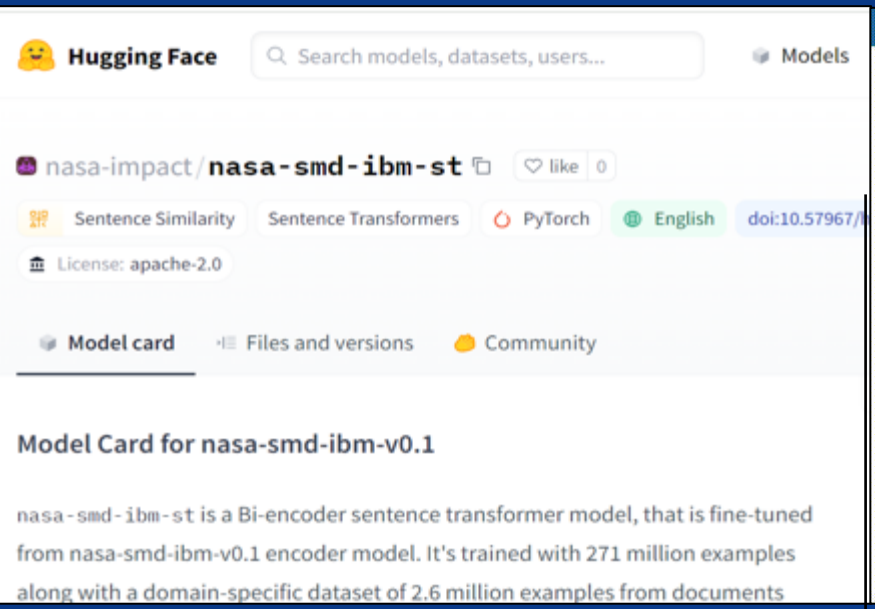
Implement and maintain robust data services and infrastructure to support scalable and efficient data science operations

Provide data governance practices and foster the growth of AI/ML capabilities, ensuring compliance, innovation, and readiness for future challenges.

Data Science can improve all parts of the Science Research & Data Life Cycle

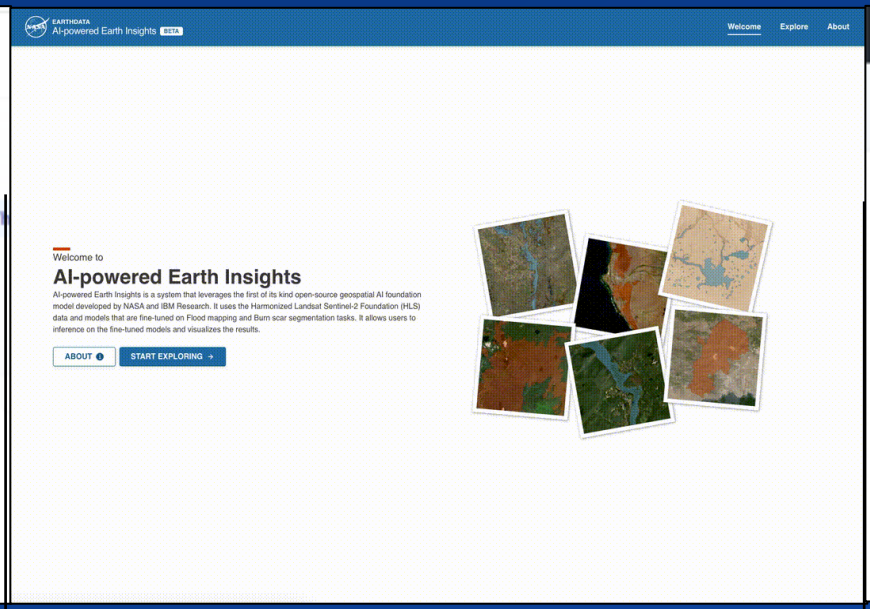
Data Science and Innovation

AI Platform and Tools



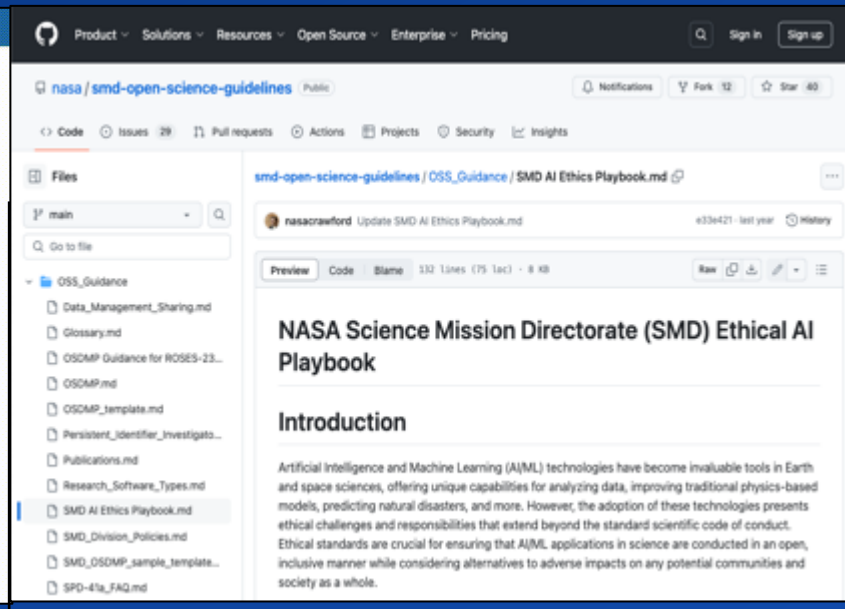
Large Language Models

NASA is developing INDUS, a Large Language Model—AI system trained on vast text data enabling them to generate human-like text—to make research more efficient by helping create hypothesis, search data and write research summaries.



Foundation Models

Foundation Models are large self-supervised machine learning models pre-trained on vast amounts of data, enabling them to perform a wide-range of tasks. Through a Space Act Agreement, NASA and IBM created a foundation model trained on NASA datasets.



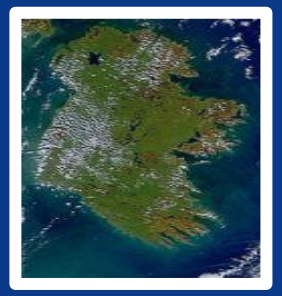
Ethical AI Playbook

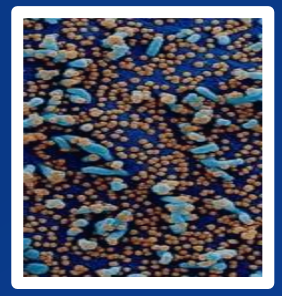
NASA's SMD in collaboration with the American Geophysical Union (AGU), created an ethical AI checklist for responsible advancements in science.

AI/ML 5+1 Strategy

The OCSDO will provide the AI expertise, system engineering, infrastructure and training to facilitate the development of…

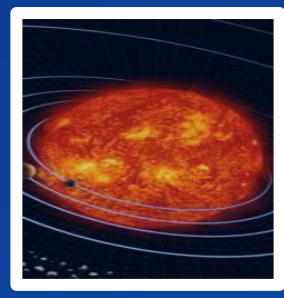
5 **Foundation Models**
one for **EACH** division


Earth Science


Bio and Physical Science


Astrophysics


Planetary Science


Heliophysics

…and

1 **Large Language Model**
for **ALL** divisions

Capacity to do 2 models / year

Open Science Implementation

How does the OCSDO implement Open Science?

SPD-41a

NASA's **Scientific Information Policy** guides researchers in ensuring that NASA-funded science, including mission data, scientific software and research publications, is openly shared from start to finish.

ROSES

NASA's **Research Opportunities in Space and Earth Sciences** program funds initiatives that promote transparency, accessibility and inclusivity in research.

TOPS

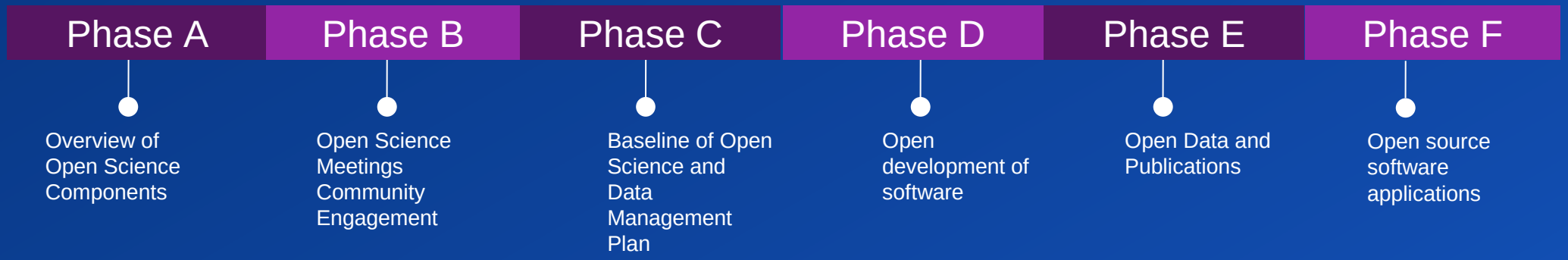
The **Transform to Open Science** program is a five-year mission to accelerate the adoption of open science among communities.

Open Science is infused into grants and missions

For grants: Open Science and Data Management Plans (OSDMPs) are required for all proposals beginning in ROSES-24. Requirements: Data and software shared at time of publication or at the end of grant. Publications publicly accessible.

For missions: Open Science is infused throughout the mission lifecycle. Project requirements have been updated to include open science including an OSDMP as a living document providing an open science roadmap for the project. This includes openly available data and developing scientific software openly to provide greater transparency and reuse.

Examples of open science activities during mission lifecycle



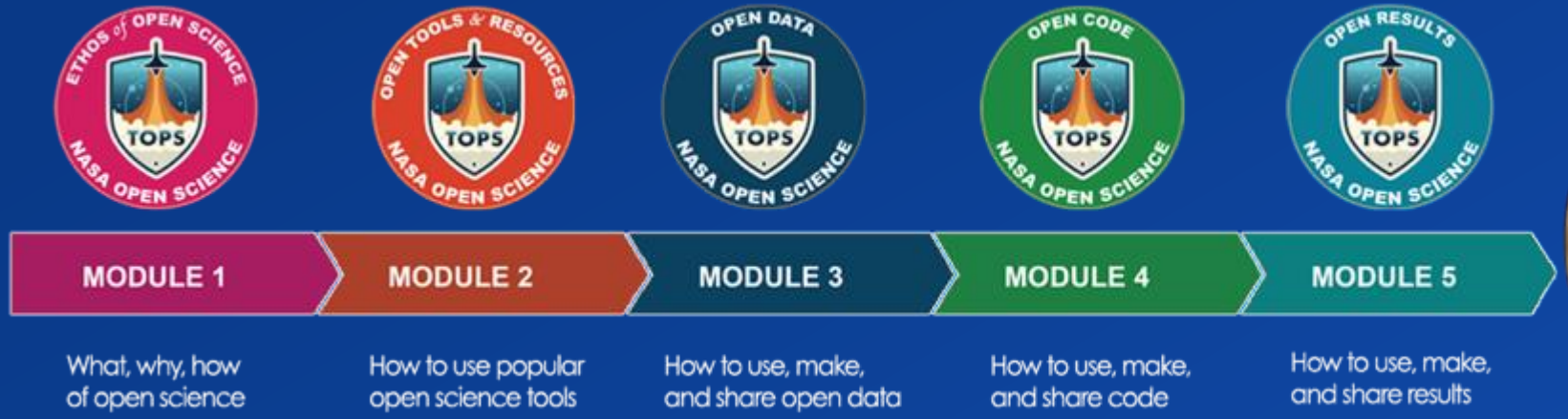
Open Science 101 Curriculum

NASA launched Open Science 101, a community-driven training program which teaches essential skills and tools for open science.

Over 2,000 people have completed it and earned their ORCID-linked digital NASA badge this year!!

Take OS101!

https://go.nasa.gov/40pPQMx



Discussion…..

- What strategies can we implement to better engage the scientific community in adopting modern data science techniques, such as machine learning and generative AI, for analyzing our vast and diverse observational data, while addressing their concerns about the reliability and validity of these methods compared to traditional physics-based models?
- What are the consequences of only being able to release 1-2 new foundational AI models / year?
- What are other things we can do to accelerate adoption of open science that will better enable breakthrough science?

BREAK

Committee will reconvene at 4pm ET

Committee Discussion

Meeting Adjourned

Committee will reconvene at 10:15am ET on October 9, 2024

NAC SCIENCE COMMITTEE FALL MEETING

October 8-10, 2024

Designated Federal Officer (DFO) Introduction

Nathan Boll

Executive Secretary

Overview of Agenda

TUESDAY:
NAC Meeting Reports (May, October)
NASA Science Mission Directorate Update
Panel Discussion: NASA IDEA Initiatives and SMD Updates
Panel Discussion: SMD Open Science Initiatives Update
Committee Discussion (90 min)
[note that we do not have public comment/Q&A on agenda until Thurs (10 min)]

WEDNESDAY:
DAC Chair reports
Panel Discussion: Climate Change and Earth System Science Strategy
Panel Discussion: Space Weather Hazard Mitigation and SMD Roles
Committee Discussion (90 min)

THURSDAY:
Public Lecture: OSIRIS-REx
Public Comment Period
Outbrief to NASA SMD

National Aeronautics and Space Administration

Division Advisory Committee Chair Reports

Heliophysics Advisory Committee

Astrophysics Advisory Committee

Biological and Physical Sciences Advisory Committee

Earth Science Advisory Committee

Planetary Science Advisory Committee

National Aeronautics and Space Administration

Heliophysics Advisory Committee (HPAC) Report to the NAC Science Committee

Paul Cassak, West Virginia University and HPAC Chair

October 9, 2024

HPAC Members

- Aroh Barjatya (Embry-Riddle Aeronautical University)
- Dave Brain (University of Colorado, Boulder)
- Paul Cassak (West Virginia University), Chair
- Nicole Duncan (BAE Systems, Inc.)
- Christoph Englert (U.S. Naval Research Laboratory), Vice Chair
- Matina Gkioulidou (Johns Hopkins University Applied Physics Laboratory)
- Farzad Kamalabadi (University of Illinois, Urbana-Champaign)
- Laura Peticolas (Sonoma State University)
- Chadi Salem (University of California at Berkeley)
- Lisa Upton (Southwest Research Institute)
- Marco Velli (University of California, Los Angeles)
- Jia Yue (Catholic University of America)
- Eric Zirnstein (Princeton University)

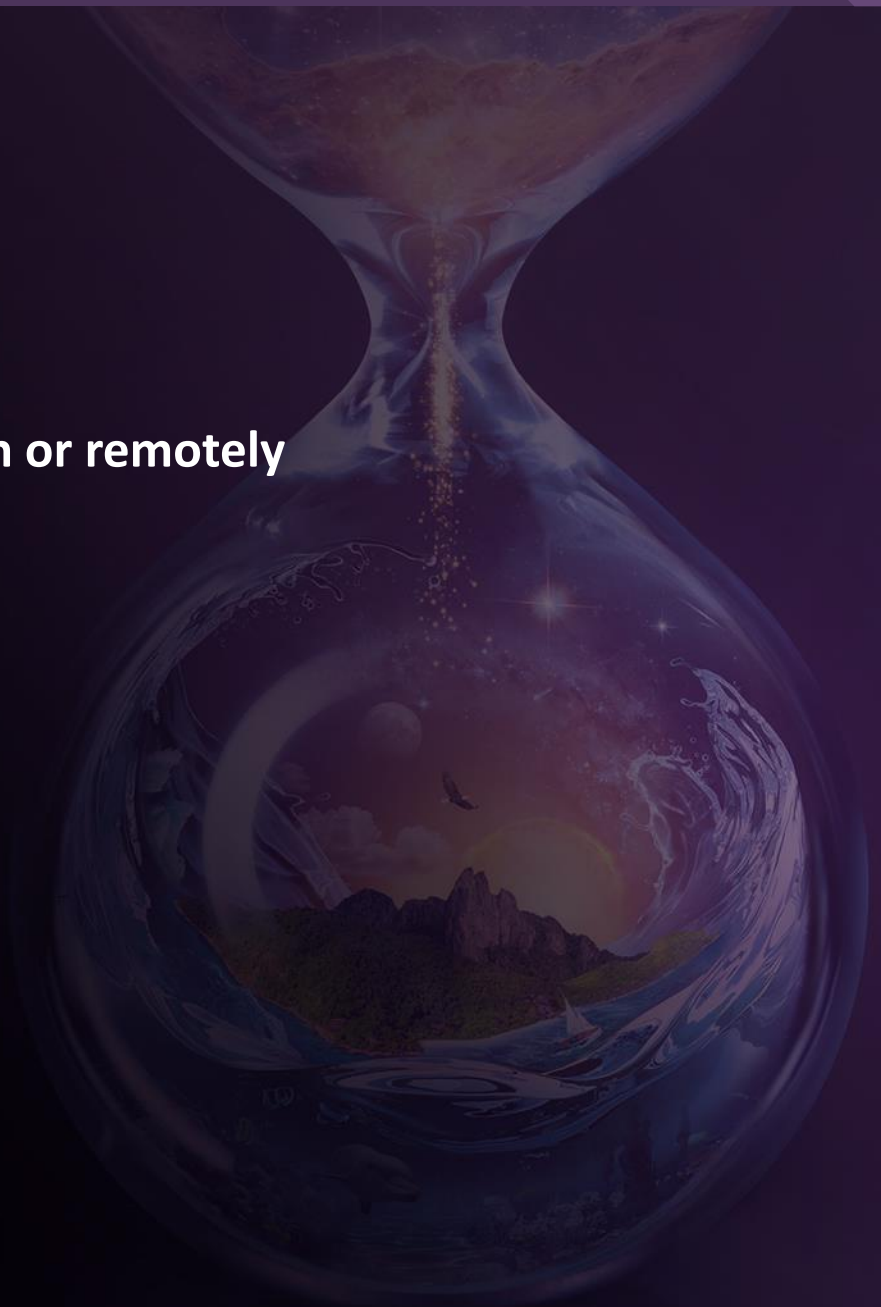
- Janet Kozyra, NASA Heliophysics Division, Designated Federal Officer (DFO)

HPAC Meetings since the last NAC SC Meeting

June 17-18, 2024; all HPAC members were present in person or remotely

Next HPAC Meeting

October 22-24, 2024; @ NASA HQ



HPAC Meeting

Location – NASA HQ
June 17-18, 2024

- **Agenda items:**

  - **NAC Science Committee – Recent Meeting Report, Dr. Paul Cassak**
  - **Space Weather Council – Directions, Dr. Kelly Korreck**
  - **R&A Program – Updates & Discussion, Dr. Therese Jorgensen**
  - **DRIVE Science Centers, Dr. Janet Kozyra**
  - **Outreach – Citizen Science, Dr. Elizabeth MacDonald**
  - **Heliophysics Division Update & Response to Past HPAC Recommendations, Dr. Joseph Westlake**
  - **Heliophysics System Observatory – Updates, Dr. Joe Westlake and Elizabeth Esther**

- **HPD/HPAC are recalibrating our approaches, processes and procedures with new Division leadership**
  - **"Kudos, Feedback, Notes, and Requests"**
    - **A collection of items for which a formal response from HPD is not necessary; examples:**
      - **"We laud HPD for its effective and broad April 2024 eclipse outreach successes"**
      - **"HPAC voted to pass along the February 2024 Space Weather Council (SWC) report to HPD"**
      - **"We appreciate the efforts by HPD to provide slides before the HPAC meeting this time, and request the slides one week in advance for future HPAC meetings"**
  - **"Suggested Agenda Items for the Next HPAC Meeting (As Of Now)"**
    - **New approach for helping contribute to the agenda items of the next HPAC meeting**

- **Space Weather Council (SWC) Report**
  - **On Research to Operations to Research (R2O2R) – It was noted that ESD's Earth Action Program is a valuable analog for HPD's space weather efforts and warrants collaboration as there are overlapping interests**
  - **The science side of the upcoming Artemis program has been through PSD; the space weather community needs to stay informed**

- **Findings and Recommendations (Relevant to the NAC SC)**
  - **Findings on Research and Analysis (R&A) Proposal Pressure**
    - **Proposal pressure is reaching a crisis – funding for R&A is falling relative to inflation and the number of proposal applications is significantly increasing since the start of the pandemic**
  - **Findings on Metrics to Measure the Health of the Heliophysics R&A Program**
    - **HPAC is working with HPD to codify what metrics of the R&A program should be provided to HPAC**

- **Findings and Recommendations (Relevant to the NAC SC)**
  - **Finding and Recommendations on the Proposed Heliophysics System Observatory (HSO) Extended Mission Framework**
    - **HPD is thinking about how long they can carry individual missions; there is a need for clear expectations, guidance, and a policy that does not pit missions against each other**
    - **HPAC provided advice about the new proposed extended mission process**
  - **Finding and Recommendation on Legacy Data**
    - **HPAC recommended "that HPD evaluate the ROSES landscape to find the best avenue for researchers to submit proposals for the analysis of legacy data and/or adjust solicitation language to make it clear to the community that these proposals may also be considered competitive."**

- Follow-up on a comment from last SC meeting
  - There was concern from another DAC (ESAC) about the funding of cubesat missions by the Heliophysics Division would burden the Deep Space Network (DSN), but this is not a significant concern – most cubesats use the Near Space Network (NSN)
- Status of Geospace Dynamics Constellation (GDC)
  - Awaiting results of the Congressionally-mandated report on what it would take to launch it this decade
- Decadal Survey coming soon
  - Should be released soon (this month?)
- Upcoming meeting topic – the inappropriate treatment of minoritized members (especially women) and a lack of it being addressed properly
  - Need “all hands on deck” approach from the community, societies, and agencies to address systemic structures that need to be changed to provide appropriate support to members of the community in need

National Aeronautics and Space Administration

Astrophysics Advisory Committee Update

Kelly Holley-Bockelmann, Chair

10/9/24

Kelly Holley-Bockelmann; Chair – Vanderbilt University

Daniela Calzetti – University of Massachusetts, Amherst

Regina Caputo – Goddard Space Flight Center

Hsiao-Wen Chen – University of Chicago

Jessica Gaskin – Marshall Space Flight Center

Erika Hamden – University of Arizona

Shirley Ho – Flatiron Institute

Shardha Jogee – University of Texas, Austin

Alina Kiessling – Jet Propulsion Laboratory

Mark Mozena – Planet Labs Inc.

Rebecca Oppenheimer – American Museum of Natural History

Ilaria Pascucci – University of Arizona

Grant Tremblay – Harvard-Smithsonian Center for Astrophysics

Sarah Tuttle – University of Washington

APAC Summer Meeting

NASA HQ/online
July 23-24, 2024

Tuesday 23 July		
9:00 a.m.	Introduction and Announcements	David Morris/Grant Tremblay/Kelly Holley-Bockelmann
9:05 a.m.	Astrophysics Division Update	Mark Clampin
11:00 a.m	OPCR Committee Report	Rob Kennicutt
11:30 a.m.	OPCR Discussion	APAC members
12:00 p.m.	Public Comment Period	
12:15 p.m.	Lunch	
1:15 p.m.	Senior Review CFP Presentation	Linda Sparke/Janet Letchworth
1:45 p.m.	Senior Review CFP Presentation Disc	APAC members
2:00 p.m.	APD Tech Dev/Small Mssn Balance	Dominic Benford
2:30 p.m.	APD Tech Dev/Small Mssn Balance Disc	APAC members
3:00 p.m.	Break	
3:15 p.m.	TDAMM Comms SAG Report	Jamie Kennea/Judy Racusin
3:45 p.m.	SCaN Comms Presentation	Greg Heckler/Peter Schemmel
4:15 p.m.	Comms Discussion	APAC members
4:45 p.m.	Wrap up for Day 1	Grant Tremblay/Kelly Holley-Bockelmann

APAC Summer Meeting

NASA HQ/online
July 23-24, 2024

Wednesday 24 July		
9:00 a.m.	Opening Remarks	David Morris/Grant Tremblay/Kelly Holley-Bockelmann
9:05 a.m.	AWESOM SAG Update	Ryan Hickox
9:35 a.m.	AWESOM SAG Discussion	APAC members
10:00 a.m.	FINESST Update	Nino Cucchiara
10:30 a.m.	Break	
10:45 a.m.	PAG Updates	Ilaria Pascucci/David Pooley/Shouleh Nikzad
11:30 a.m.	SPHEREx Update	Jamie Bock
12:00 p.m.	Roman Update	Vanessa Bailey/Joshua Schlieder
12:40 p.m.	Public Comment Period	
12:50 p.m	Discussion of APAC Topics from the Community	APAC members
1:00 p.m.	Lunch	
2:00 p.m.	Discussion	APAC members

Next Meeting: November 7-8, 2024

Operations Paradigm Change Review for Hubble and Chandra

Charge to the committee

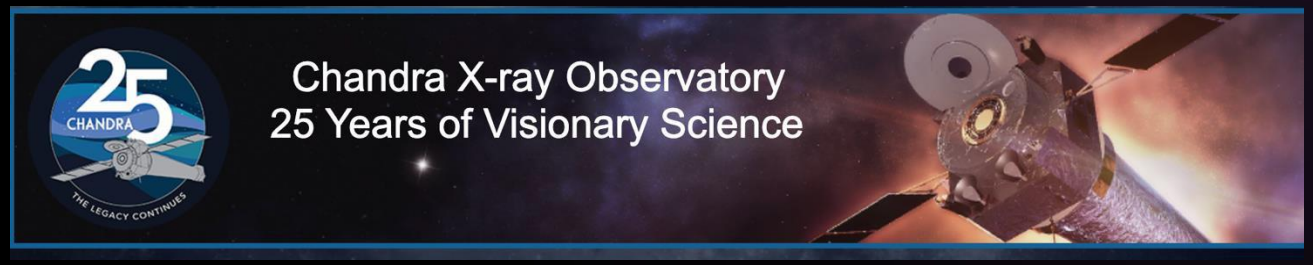
Present findings of strengths and weaknesses of the options presented by HST and Chandra to meet the budget guidelines

No recommendations are requested, this is not a FACA committee, and unanimity is not required

Review Process

April 20: Submissions by HST and Chandra distributed
May 7: Online meeting of committee
May 8: Presentation by HST (90 min + discussion)
May 9: Presentation by Chandra (90 min + discussion)
May 16: Follow-up meeting of committee
May 20: Summary report presented to NASA HQ
(most of these slides are taken from that report)

Submissions followed a prescribed format (text and budgets) and certain categories of costs could not be reduced.



Operations Paradigm Change Review for Hubble and Chandra

Summary of Findings - both

Chandra and HST are Great Observatories serving huge observing communities and producing frequent scientific breakthroughs from observations and archives, with increasing numbers of publications

Both received top marks in Senior Reviews: high return on the dollar

Annual operating cost a few percent of capital cost provides large and guaranteed return on investment

Both are unique: no other equipment now or approved for construction could replace them

Both have new scientific projects in synergy with JWST and time domain multi-messenger astronomy (a top priority in Decadal Survey)

Both are in good health, operating efficiently, in high demand (oversubscription), archiving and distributing data, and supporting widely used analysis tools. The thermal control issues facing Chandra have not had any impact on its scientific productivity.

Both have limited lifetime, but should run well into next decade

Both have approved end-of-mission plans

General Observer and Archive program funding ensures observations analyzed completely and published promptly. These programs also provide funds to train the future scientific leaders.

Archives widely used by astronomers around the world, including at small institutions that traditionally have more diverse student bodies.

Operations are highly streamlined and optimized after years of improvements - even small budget cuts require losses of services and capabilities

Operations costs are mostly staff: significant cuts would require RIFs, with legal implications and irreversibility

Ending either of these missions now would be premature and would have a large, permanent impact on science and the astronomical community

HST

For reference the OPCR guideline budgets for FY25-FY29 compared to FY23

FY23	FY25	FY 26	FY27	FY28
105.6M	88.8M	87.5M	87.7M	82.9M

- HST explored reductions in three areas: GO funding, discontinuing instrumentation modes, and reduced (i.e., higher risk) mission operations.
  - Option A (in guide): most savings from reductions in GO funding
  - Option B (in-guide): elimination of instrument modes, less reduction in GO funding
  - Option C (in-guide): reduced mission ops, less reduction in GO funding
  - Option D (over-guide): avoid reduced capabilities, maintain most GO funding

Chandra

For reference the OPCR guideline budgets for FY25-FY29 compared to FY23

FY23	FY25	FY 26	FY27	FY28
68.3M	41.4M	26.6M	26.6M	26.6M

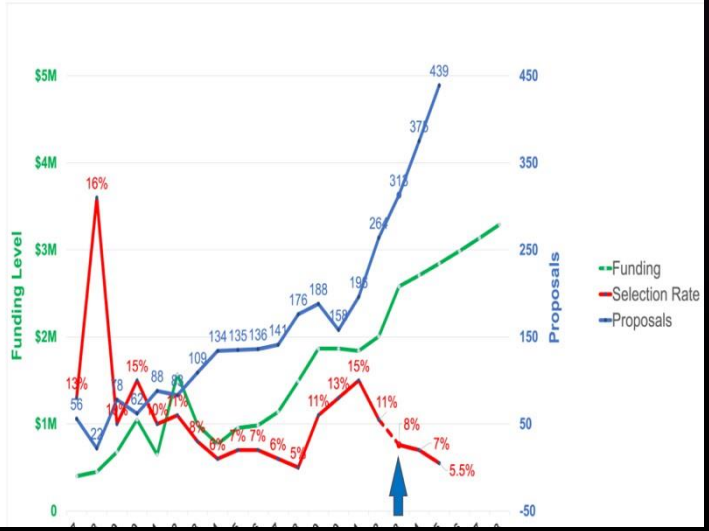
- The Chandra project had a considerably more challenging task, with much deeper cuts in the FY25 PBR
- The only viable in-guide option was to initiate termination of the mission (approved plan already in place). The other three options are over-guide, but with Options II and III entailing major reductions in funding compared to FY23 levels.
- Options:
  - Option I (in-guide): mission closeout
  - Option II (over-guide): "TSL" meaning TDAMM/Synergy/Legacy program elimination of regular GO observing and reduced user support
  - Option III (over-guide): "TSL+" meaning Option B with increased levels of user support
  - Option IV (over-guide): Full capability mission

FINESST Working Group Findings

FINESST for Astrophysics

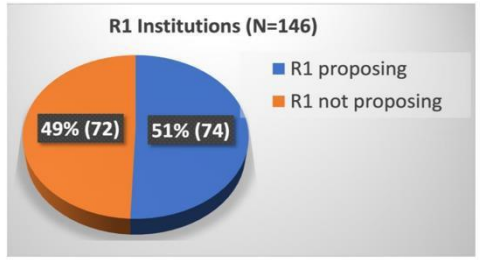
The program is incredibly successful in terms of submission numbers (313 in 2023, +20%).
A deeper dive into the different aspects of the program (from solicitation language, to type of submitting institutions, and proposal evaluation) has led APD to reassess our participation in the SMD model.

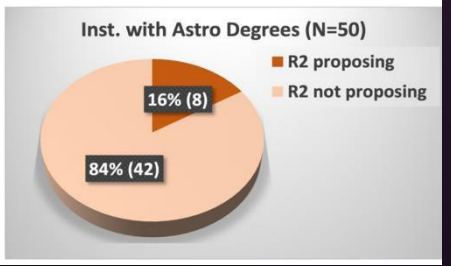
- Despite an increase in funding allocation, the success rate remains below SMD ideal target
- Astro2020 Decadal and APAC recommend higher investments in early career scientist's development
- FINESST is APD's largest program by submissions



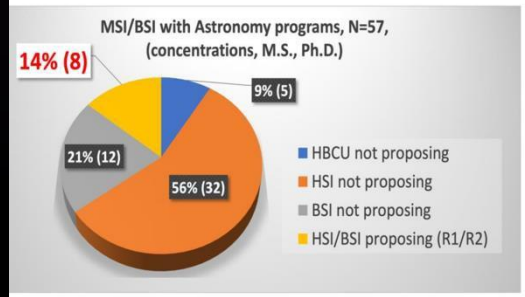
Institutions that offer Astronomy-related postgraduate degrees (aka FINESST eligible)

We consider the "R2/R3/M1/M2" that offer terminal degrees in astronomy (M.S./Ph.D.): we found 50 of them.





Of 57 MSI/BSI **with astronomy programs**, only 8 (14%) proposed, mostly R1 (5)



In Summary

We are **not reaching** a significant fraction of the astronomical community and/or there are **significant barriers** to applicants.

Not surprising, considering the Astro2020 Decadal (State of the Profession) as well as the response to the SMD RIA-23 Solicitation.

FINESST Working Group Findings

A Possible APD-focused New Program: STudent Astrophysics Research Grant (**STAR Grant**)

We recognize the different needs of the different Divisions as well as the communities they serve.
For these reasons we envision an APD-specific program, that will not impact other Division's initiatives.

Objectives:

- **Support the research** (or potential) of early career students (Master or PhD bound students)
  - Research that can advance Astrophysics and fulfill NASA objectives
  - Projects at a well defined stage, e.g. latter years of PhD projects (experienced applicants)
  - Projects at an early stage, that have potential for great discoveries (early grad students, M.S.)
- Support/increase **diversity of thoughts** (NASA strategic goals)
  - We want to serve the broader spectrum of astronomical community and its research endeavors because transformative ideas are everywhere
- Support the next generation of space-based **astrophysics leaders and role-models** (Astro2020 - State of the Profession).

Summary of the Proposed Critical Changes

1. **Having a two tiers system with different audiences and purposes**: more fair competition, responding to differing needs of the candidates/institutions, as well as better alignment to NASA APD scientific objectives
2. **Limit the number of active awards or submissions by same "Linked Organization"**: create a higher quality and manageable review process
3. **Full panel review**: provide deeper scientific review discussion, high quality and more constructive feedback to the proposing students

We ask the APAC and the community for feedback on these ideas and possible implementation of the STAR Grant as stand alone APD solicitation

FINDINGS

The *Chandra*/*Hubble* Operations Paradigm Change Review (OPCR) findings were presented to the APAC by Prof. Robert Kennicutt. The APAC thanks and commends the OPCR committee for delivering a thorough and thoughtful analysis, especially on such a compressed schedule. The APAC was not allowed to be involved in the OPCR process, did not receive the report, and was informed before the meeting that the APAC was not asked to comment on the results. We note, however, that fruitful discussion during the meeting clarified that APD would welcome comments from APAC on the OPCR. While we are sympathetic that APD is facing severe budget pressure and that difficult decisions must be made, we remain concerned about the lack of oversight and transparency in this process; the APAC is a Federal Advisory Committee charged with making formal recommendations on the priorities of the Astrophysics Division and should therefore at least be cognizant of any planned major changes to the astrophysics portfolio before they are made. We also note that an important role of the APAC is to inform the community about APD decisions and rationale, and that this function would be valuable to help the community restore trust in the Division.

The APAC also remains concerned that NASA has taken preemptive budget actions that have led to severe yet preventable impacts. In balancing the budget, the APAC urges the APD to also consider balancing science and budget. In particular, there are strong synergies between current and future missions, including Hubble, Chandra, JWST, and Roman, to support ambitious projects and enable big discoveries. The APAC understands that a nimble response is sometimes needed, particularly given the unpredictability of the appropriations cycle or when operating under a continuing resolution, but premature cancellation of Hubble or Chandra have downstream effects that will last a generation.

We also acknowledge that the responsibility for how a mission allocates its budget is not fully in APD's control. To both APD and STScI, the APAC reiterates its April 2024 letter: *'While NASA plans with the President's Budget Request in mind, the actual budgets are set by appropriators in Congress. Given the lessons learned from FY24, it would be prudent not to commit to FY25 spending plans in a way that locks in catastrophic cuts to major capabilities before Congress decides on the final budget.'*

Chandra/Hubble Operations Paradigm Change Review

The APAC understands that flagship missions do end, and recognizes the difficult task of balancing the portfolio amid a highly constrained budget. However, NASA's own OPCR committee found that both Chandra and Hubble are *"highly streamlined after years of improvements"*, while both missions remain heavily oversubscribed, scientifically productive, and synergistic with current and future ground- and space-based observatories, including JWST and Roman. The APAC recommends that budget cuts to Chandra and Hubble be kept at the minimum possible level, and that the irreversibility of workforce layoffs be given greater priority in making budget trades. Clearly, investment in future missions and balancing the portfolio is important, but the community-wide damage done by irreversible cuts to two operating and highly productive Great Observatories now can have lasting effects that far outweigh the benefits of accelerated technology maturation for a facility that may be decades away from launch. We recommend that APD take all reasonable action to preserve the unique science capabilities of these two operating Great Observatories, and to retain the resources needed to support the analysis and publication of their science output. Both chambers of Congress, through a House Authorization bill and two Commerce, Justice, Science Appropriations bills, have expressed clear opposition to reductions in *Chandra*'s operating budget. The APAC recommends that APD take no irreversible action with regards to Chandra and Hubble staff until completion of the next Senior Review, which should come at a time when we will have more clarity as to the FY25 Appropriations process.

Further, the APAC recommends that, going forward, APD follow more transparent procedures for large changes to the budget, priorities, and mission portfolio. The APAC strongly recommends that APD defer making major, irreversible choices until they are absolutely required to, and to defer to established community processes such as the Senior Review, mid-Decadal, and Decadal Surveys.

STAR Grant

The APAC recommends that APD implement the STAR Grant as soon as is feasible. Of the changes mentioned in the presentation, the APAC recommends: 1) adopting tracks that separate early researchers from those with thesis research well underway; 2) increasing the award amount; 3) exploring a full panel review; and 4) requiring a budget only from students with awards. The APAC recommends against limiting the number of proposals submitted from each institution, as this may have the counterproductive effect of reducing submissions from under-resourced institutions that may lack the infrastructure for internal proposal evaluations. To broaden participation beyond R1 Primarily White Institutions (PWIs), APD may consider exploring a Campus Champion model, in which designees at institutions are responsible for raising awareness about STAR and assisting with the application process.

National Aeronautics and Space Administration

BPAC Report to NAC Science Committee

Jamie S. Foster, Chair

October 9, 2024

BPAC Members

Kenneth Davidian, International Space University
William Davis, NASA Johnson Space Center
Jamie Foster (Chair), University of Florida
Simon Gilroy, University of Wisconsin-Madison
Mary Guenther, Commercial Spaceflight Federation
Nathan Lundblad, Bates College
Maren Mossman, University of San Diego
Aleksandra Radlinska, Pennsylvania State University
Ali Rangwala, Worcester Polytechnic Institute
Kathleen Rubins, NASA Johnson Space center
Danilo Tagle, National Center for Advancing Translational Sciences
Petia Vlahovska, Northwestern University
Mark Weislogel, IRPI, LLC

Executive Secretary: Mike Robinson, NASA Headquarters

List of recent and upcoming meetings/dates

GPRAMA – December 2023 – meeting of experts

BPAC officially formed in 2024

First official meeting April 25 – 26, 2024

GPRAMA Review – November 20, 2024

BPAC Spring Meeting

NASA HQ
April 25 – 26, 2024

Day 1

- National Academies Decadal Survey Update – Krystyn Van Viliet
- BPS Response to the Decadal – Lisa Carnell
- NASA ISS Update – Jennifer Buchli
- CASIS ISS Update – Mike Roberts
- Commercial LEO Destinations – Kirt Costello

Day 2

- Space Biology Program Update – Sharmila Bhattacharya
- Fluids, Combustion and Materials Program Update – Brad Carpenter
- Fundamental Physics and Soft Matter Program Update – Mike Robinson

1. Budgetary Impacts on Biological and Physical Sciences

Findings:

1. As the Decadal Survey recommends significantly increased funding of BPS research areas, BPS will need additional investment to serve as a catalyst for the greater BPS community. This aspect is even more imperative if BPS will be required to account for operational expenses (e.g., crew time, launches, platform access, etc.) on CLDs, as these are currently covered by other NASA divisions and directorates.
2. There is a risk that a limited BPS budget may impact the capacity and momentum of BPS experiments, thereby potentially resulting in technical and schedule delays in upcoming missions (e.g., Artemis).
3. The planned cuts to the annual ISS operating budget (estimated to be 20%) may significantly constrain the amount of science that can be accomplished by BPS in the final years of the ISS despite the station now being a mature and productive platform.

Recommendations:

1. BPS and SMD leadership continue to advocate for increased funding, on the order of 30% annually, to achieve Decadal Survey recommendations. Advocacy can include direct funding requests as well as the continuation of building partnerships across NASA and other agencies to maximize resource utilization.
2. As BPS continues its Decadal Survey road mapping efforts, clarify to BPAC, and the larger BPS research community, the procedures used to address budgetary issues and prioritize targeted elements of the survey.
3. Despite clear budget constraints maintain regular proposal cycles that includes ground-based research.
4. Consider expanding collaborations with other government's space agencies to leverage BPS funding.

2. Decadal Survey Road Mapping and Implementation

Findings:

1. BPS Roadmap activities to identify prioritized research activities are needed and valuable; however, the planned timeline for road mapping may not be fast enough to help the research community align their proposed activities before the next grant cycle.

Recommendations:

1. Quickly provide community guidance and highlight initial areas of priority from the Decadal Survey to research community prior to the next RFP announcement.
2. As BPS refines its research roadmaps, coordinate efforts with other SMD divisions and directorates to optimize efforts and timing.
3. Consider moving key ground analogs and facilities to institutions outside of NASA centers to reduce costs and increase accessibility of facility beyond normal NASA working hours, thereby increasing productivity and usage of the facilities.

3. Information and Data Exchange with Commercial Providers

Findings:

1. A significant factor influencing BPS mission success in the next decade will depend on how quickly Commercial LEO Destinations (CLDs) platforms achieve operational status. It will take time for CLDs to match the current capabilities and capacities of the ISS.
2. BPS has needs in terms of requirements and generated best practices learned from ISS research that need to be included in the design, development and operations of the CLDs.
3. NASA was unable to provide insight to BPAC on the level of community and agency access to commercial flight test data relevant to BPS objectives, which was concerning.
4. This lack of critical data sharing appears to be inconsistent with the NASA Open Science Initiative.

Recommendations:

1. Ensure BPS maintains transparent and rapid communication with CLDs to ensure NASA requirements and best practices are conveyed to CLDs to enable CLDs to incorporate into their designs.
2. Ensure BPS has access to all data from test flights and experiments related to BPS research. Although considerations must be made for protecting proprietary and other controlled information, this data should be openly shared with the greater BPS community as much as possible.
3. Continue to assess and identify potential CLD external schedule and priority impacts on BPS research to ensure there are contingency plans for events beyond the control of BPS.

4. Optimizing BPS Science Aboard the ISS

Findings:

1. There is risk that BPS research efforts on the ISS are not fully maximizing ISS capabilities, thereby limiting the scientific return for the remaining lifespan of the ISS.

Recommendations:

1. Develop approaches to increase experiments that take greater advantage of on-orbit analysis rather than sample return .
2. Create a pipeline of “on-demand” science experiments that can be sent and stored on ISS. These ”on-demand” experiments could be completed in between docked missions or during vehicle slips when crew time becomes available, thereby increasing the efficiency and output of BPS science and be more adaptable to CLDs if upmass/downmass and cold stowage is restricted.
3. Utilize procurement models that facilitate rapid development of hardware that serves more like an agent (e.g., Air Force Space Enterprise Consortium) to delegate approval authority to lower levels, thereby increasing decision speed and reducing entry resistance for more entities engaging in BPS-related research.

5. Workforce Development

Findings:

1. Gaps in research funding threaten entire generations biological and physical space researchers in areas of micro- and partial gravity science.

Recommendations:

1. Create short videos highlighting overall BPS achievements and impact of research that can be used as a student engagement tools and assist in raising BPS profile amongst stakeholders.
2. Consider partnering with NASA Office of STEM engagement to identify an approach for longitudinal analysis of funded students to measure and assess the impact of IDEA-related initiatives. Establish criteria of success for the engagement programs.
3. Leverage usage of the NASA FINESST program by expanding number of BPS-funded graduate students.

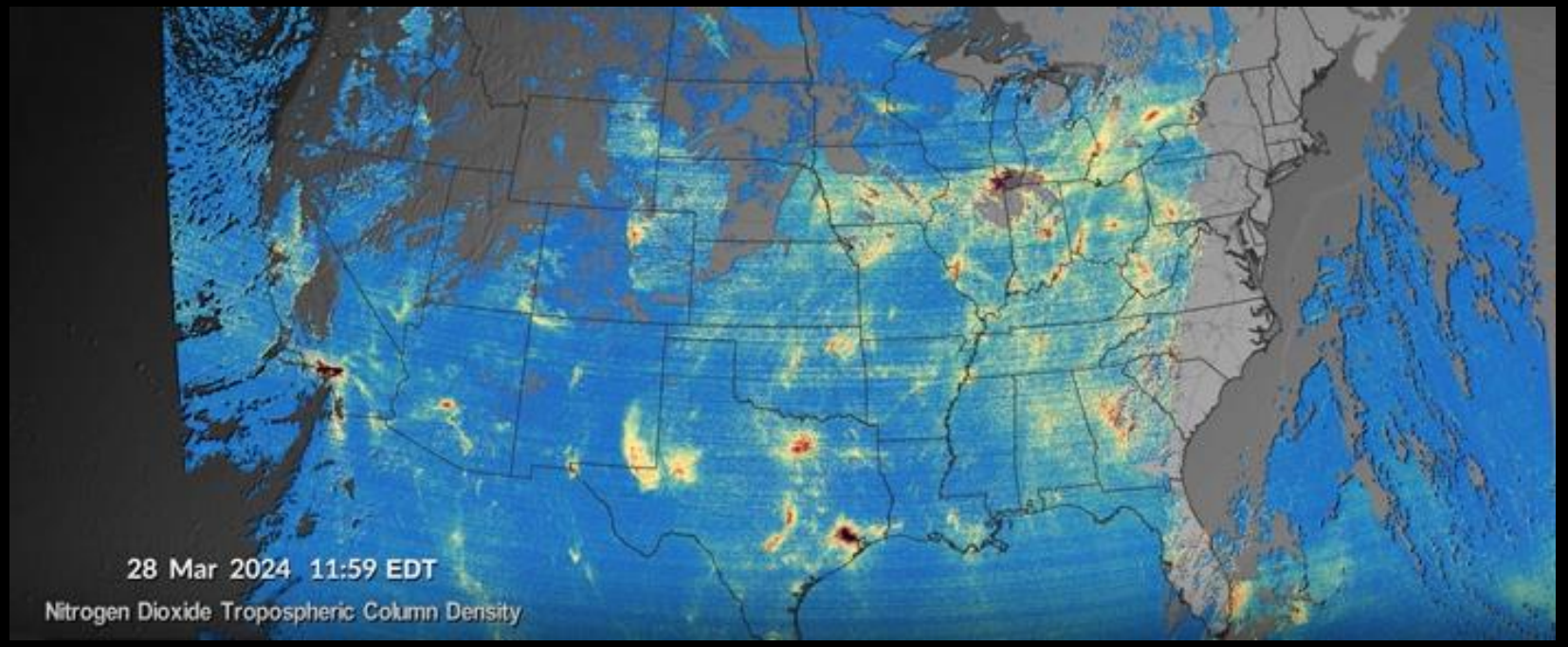
6. Additional Infrastructure for BPS

Findings:

1. There is a critical need for the construction or increased access to partial gravity drop towers to test key physical processes (e.g., combustion, fluids) to support upcoming missions (e.g., Artemis).
2. Future platforms, such as the Lunar Gateway, must have the infrastructure necessary to support these lines of research to uphold the advancement of fundamental physics research in space-based environments beyond the ISS.

Recommendations:

1. BPS should consider a specific funding request from Congress to construct a US-based partial gravity drop tower, or facility, to ensure the success of critical upcoming missions (e.g., Artemis).
2. Examine and potentially leverage successful NASA-ESA collaborations where research (e.g., partial gravity) can be co-funded and enhance international participation.
3. Leverage its distinctive role in providing new types of environments for quantum science and technology development that can be accessible to other institutions for the expansion of research and workforce development opportunities.
4. Explore having a joint proposal for soft matter and fluid dynamics.



Earth Science Advisory Committee (ESAC) Report

Sara Tucker, ESAC Chair

NASA Advisory Council Science Committee
Meeting at KSC
8-10 October 2024

NASA Earth Science Advisory Committee

- ESAC Executive Secretary - Lucia Tsaoussi
- ESAC Members
  - Christine Chiu – University of Colorado
  - Indrani Das - Lamont-Doherty Earth Observatory (LDEO)
  - Belay Demoz - JCET, UMBC
  - Venkataraman Lakshmi - University of Virginia
  - Jennifer Logan - Northrop Grumman Aerospace Systems
  - Rowena Lohman - Cornell University
  - Dylan Millet – University of Minnesota
  - Helen Pillar – Univ. Texas
  - Beth Plale - Indiana University
  - Melanie Preisser – York Space Systems
  - Sara Rivero-Calle – Skidaway Inst. Oceanography, U. of Georgia
  - Jennifer Watts – Woodwell Climate
  - Robert Wright - University of Hawaii
  - Lisan Yu - Woods Hole Oceanographic Institution
  - Sara Tucker, Chair – BAE Systems

April 2024 ESAC Meeting

- The committee met 16 & 17 April 2024 in Washington, DC and online.
  - April 16 meeting: held jointly with the Applied Sciences Committee (ASAC)
  - April 17 meeting: ESAC only
- Topics presented & discussed:
  - Earth Science Division Update: K. St Germain
  - Earth Science to Action Strategy (ES2A): K. St Germain
  - Earth Science Decadal Survey Perspective: A. Nolin, personal perspective
  - Flight Program Update: S. Schwinger
  - Research Program Update: J. Kaye
  - Earth Action Program Update: T. Wagner
  - ESTO Program Update: M. Seablom
  - Earth Science Data Systems Update: J. Scott for K. Baynes
  - Earth System Observatory (ESO) Mission Update: J. Robinson
  - ESD Communications Strategy: W. Mihm
  - Digital Twins for Connecting Data, Models and Decision-Making: S. Boukabara
  - Earth System Observatory Integration: T. Wagner

Earth Science to Action Strategy

Virtuous Cycle
- User needs inform next iteration of programs, missions and initiatives

Public Understanding & Exchange
- Put more scientific understanding into public sphere
- Deliver applied science to users
- Participate in multi-way info exchange
- Use input to inform subsequent work

Solutions & Societal Value
- Offer models, scientific findings and info through Open-Source Science principles
- Support climate services
- Provide science applications and tools to inform decisions

Earth System Science & Applied Research
- Grow scientific understanding of Earth's systems
- Develop predictive modeling for science applications and tools to mitigate, adapt and respond to climate change

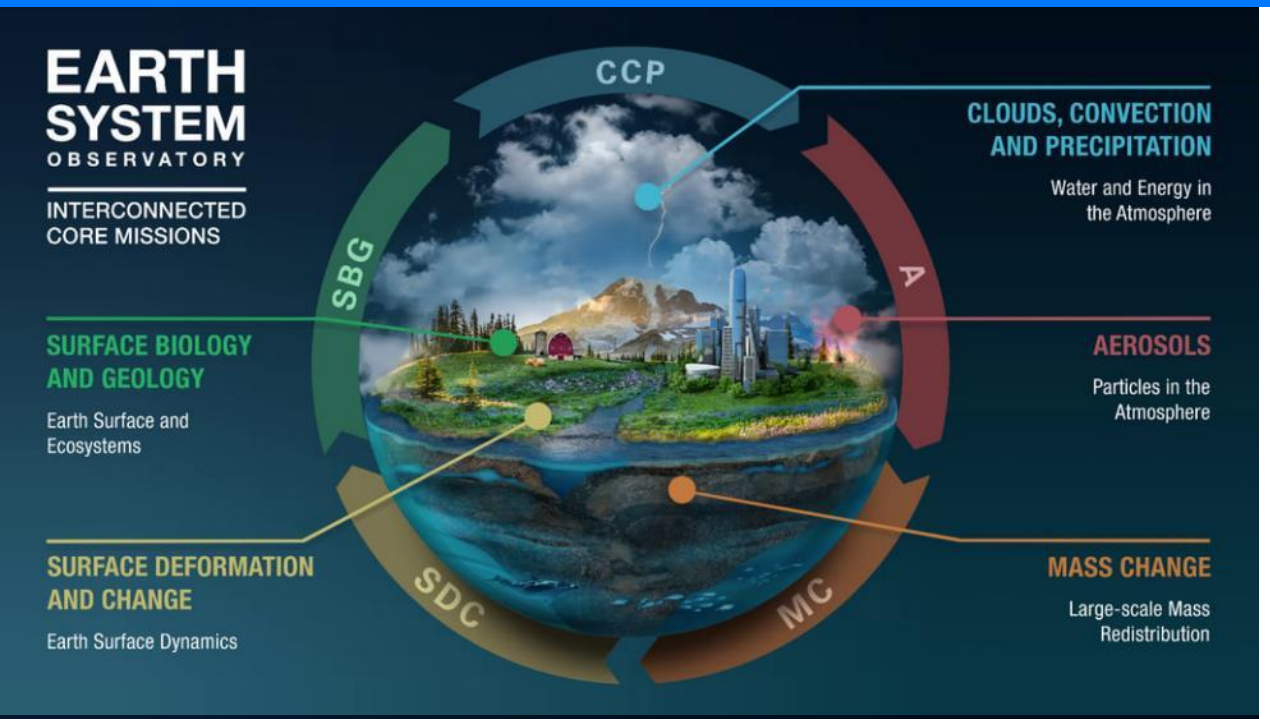
Foundational Knowledge, Technology, Missions & Data
- Technology innovation
- Earth observations missions
- Data collected from space, air and ground

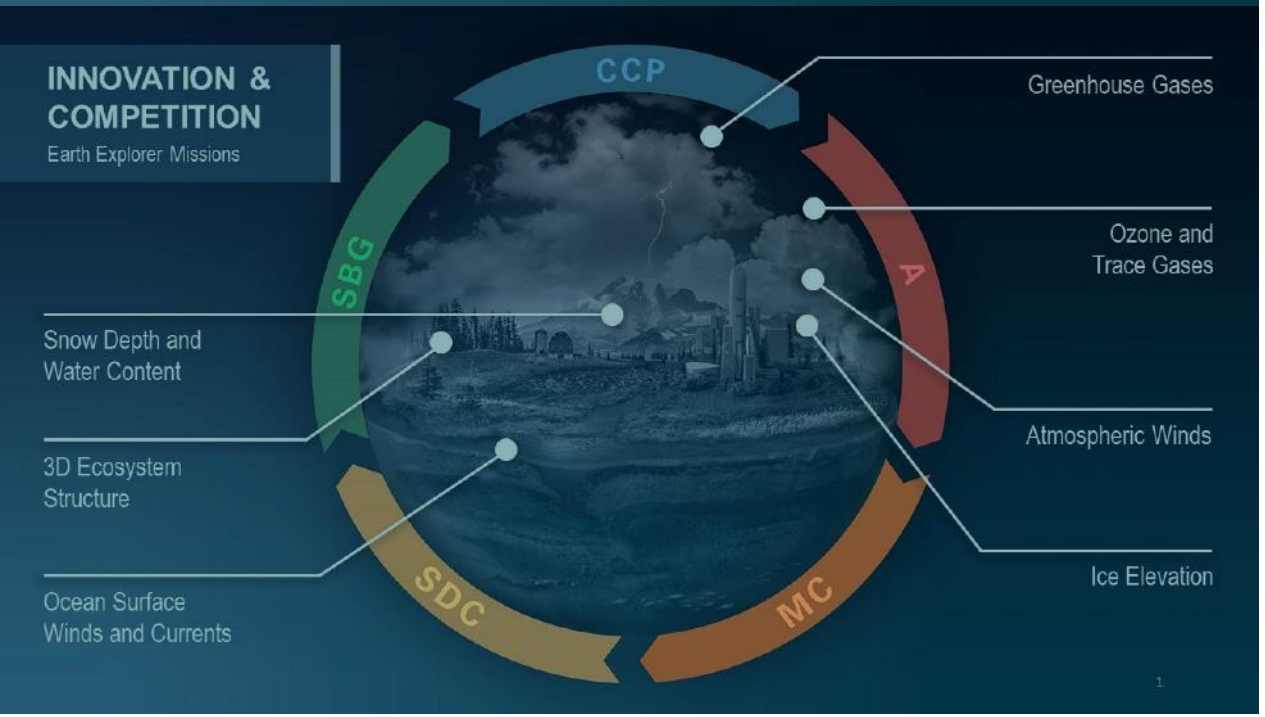
NASA earth

0213.2024

Findings & Recommendations: Earth Science to Action

- **Findings**: At a time of great climate uncertainty, NASA ESD is a critical resource and national strategic asset for enabling our country, and our planet, to understand and adapt to climate change. NASA develops and supports many of the space-based observations used to provide actionable information that can support the work of NASA's sister agencies including NOAA, USGS, and EPA.
- **Recommendation**: NASA should ensure that ES2A efforts will enhance or complement, and not replicate or conflict with, related work performed at the sister agencies.
- **Recommendation**: As NASA ESD rolls out the ES2A strategy, it should continue to do so deliberately and with empathy for the larger community – seeking input from the broader science and technology community outside of NASA centers. In addition, NASA ESD would benefit from providing the community with additional examples of requests for earth information, and descriptions of how NASA determines its unique role in addressing requests, and how it coordinates and collaborates with other agencies (e.g., USGS, DOE, and NOAA) to address these national and global needs.
- **Recommendation**: In implementing the ES2A strategy, ESD should further review and minimize the impacts of ES2A (intentional or not) on the foundation of NASA Earth Science (e.g., technology, flight mission, and R&A). ESD should avoid compromising Discovery science, the core NASA identity, and ensure messaging is clear regarding both the risks of operational applications on scientific discovery, as well as the opportunities provided by the actionable information. ESD should also carefully evaluate its current capability, barriers to optimum usage, and the need for additional computing requirements needed to meet the ES2A objectives and provide mechanisms for tracking the ES2A objectives with clear and actionable steps.





Earth System Observatory

Core Designated
Observable
Missions

Earth System Explorer: 4x Phase A Selections

- **The Stratosphere Troposphere Response using Infrared Vertically-Resolved Light Explorer (STRIVE):** Lyatt Jaegle ,University of Washington & **GSFC**
- **The Ocean Dynamics and Surface Exchange with the Atmosphere (ODYSEA):** Sarah Gille, Scripps, U. California San Diego, & **JPL**
- **Earth Dynamics Geodetic Explorer (EDGE):** Helen Amanda Fricker, Scripps, U. California San Diego, & **GSFC**
- **The Carbon Investigation (Carbon-I):** Christian Frankenberg, Cal Tech & **JPL**

Earth System Observatory (ESO)

- Planned changes to ESO missions

Changes in the AOS Planned Acquisition under the Decouple, Partner and Compete Approach

Tightly Coupled Architecture

Inclined Orbit

PMM (2029) Japan
- Radiometer (France)

AOS-Storm (2029)
- Backscatter Lidar
- Radiometer (France)

Co-Launch

Polar Orbit

AOS-Sky (~2031)
- Backscatter Lidar
- Doppler RADAR
- Microwave Radiometer
- Polarimeter
- TICFIRE Far infrared (Canada)

Co-Launch

HAWCsat (Canada)
- Aerosol and Water Vapor Limb Imager

FROM TO

Decoupled Architecture

PMM (2029) Japan
- Radiometer (France)

AOS-Storm Smallsat (2029)
- Radiometer (France)

Co-Launch

CALIGOLA (~2029) Multipurpose Lidar (Italy)
- Detectors

AOS-Sky (~2030) Microwave Radiometer Polarimeter
- TICFIRE (Canada)

Co-Launch

HAWCsat (Canada)
- Aerosol and Water Vapor Limb Imager

Competed Mission (~2031)

Details pending Community Announcement

Legend
- Directed (NASA)
- Open Phase A Trade
- Partner Contribution
- Competed (NASA)

Recommendations: Earth System Observatory

- **Finding**: The decouple, partner, and (potential) compete approach to the Designated Observable missions AOS and SBG may result in significant cost savings, but it puts at risk the ability to deliver new and improved science (e.g., aerosol-cloud interactions) over what was learned from the A-train missions. There may be additional risk in working with external partners (e.g., leaning on international missions) that may not provide NASA's level of mission assurance.
- **Recommendation**: NASA should work toward transparency in this new Earth System Observatory strategy, ensuring that the entire community is informed and aware of the opportunities it brings as well as the risks of this new approach to established and consequential legacy observations including global precipitation.
- **Finding**: The lack of an Earth Science Decadal Survey mid-term review/report raises concerns about whether decadal surveys (and mid-term evaluations) are too infrequent or inflexible for the field of Earth Science in a rapidly changing world.

Findings and Recommendations: Research and Analysis (R&A)

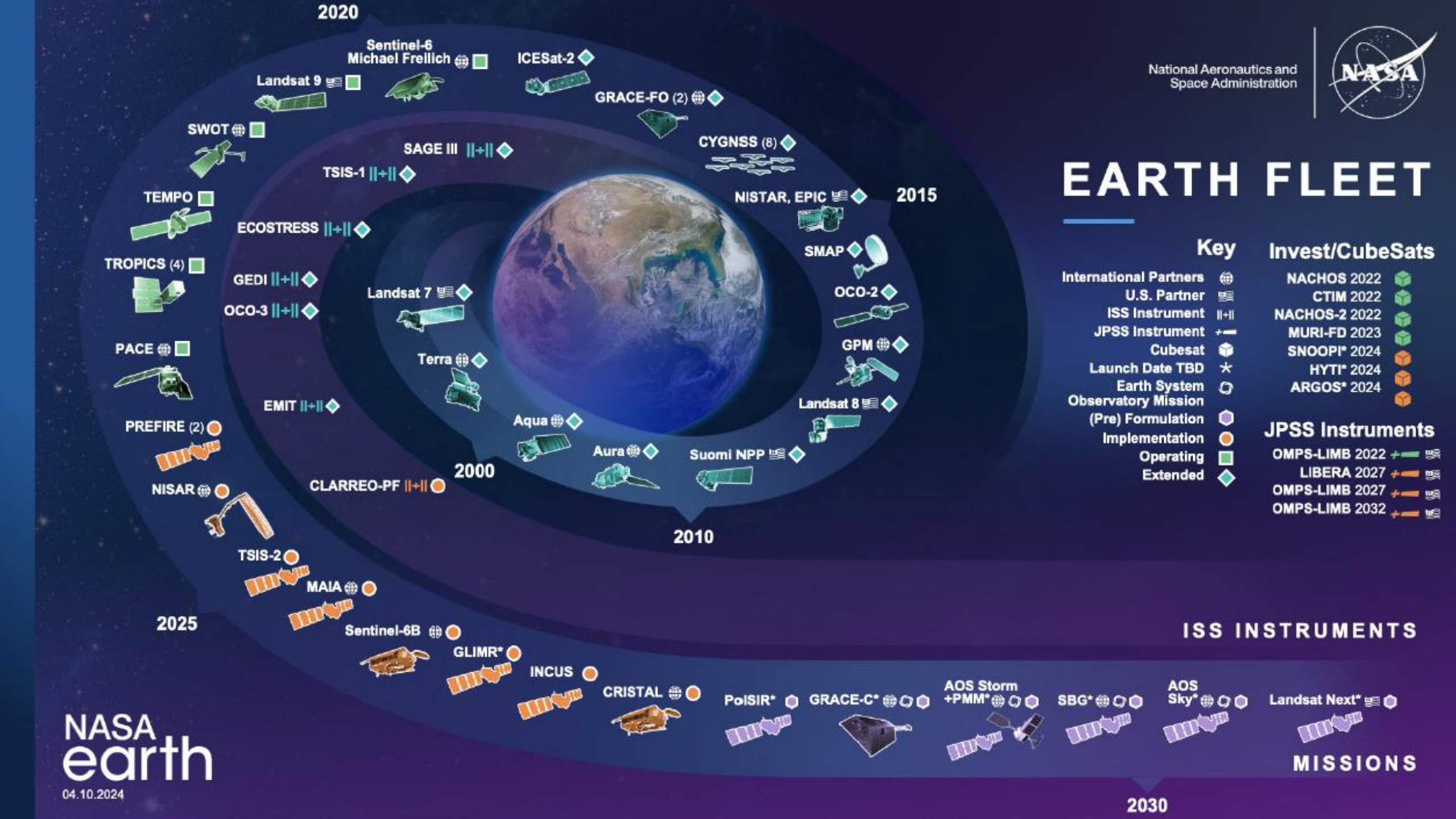
- **Finding**: The ESD R&A program has continued the strong record of scientific discovery, actively working toward DEIA goals and inspiring a new generation of NASA scientists. Along this vein, the shift in the Earth Venture suborbital proposal process, identifying the team in a subsequent step, enhances the breadth of the teams and likely decreases the burden to PI entry and thus representation in the proposal pool.
- **Recommendation**: The expansion of dual anonymous peer review and encouragement of breadth and diversity in science team formation are leading to improvements. NASA ESD R&A should continue with these important efforts and programs to engage students and faculty at minority serving institutions.
- **Finding**: The Committee recognizes the importance of a modeling strategy that recognizes the fundamental importance of observations as a guide to both traditional and machine-learning modeling activities, to ensure that ESD modeling efforts extract the maximum value from Earth observations in the form of new scientific discoveries and societal benefits.

Findings and Recommendations: Computing and Data

- **Finding**: Recognizing that all computing needs are not equal, computing will be a constraint on ESD's ability to provide products to meet ES2A goals. As NASA evolves the DAACs toward providing more open-source data, increasing amounts of commercial data and newly-generated NASA data products will continue to require more resources. In addition, ESD's High End Computing (HEC) capabilities are at their maximum capacity and aging, thus putting at risk the needed resources to support developments in AI/ML, digital twins, etc.
- **Recommendations**: Future work in ESD is heavily driven by computational capacity. ESD needs to develop a robust way to assess and capture the HEC computing needs as it moves to execute on the ES2A strategy. In addition to addressing the HEC hardware needs, resources must be provided to hire individuals that can support these objectives, ensuring computer scientists and earth scientists can work together to update/write code for modern day GPU systems, etc. In doing so, ESD should consider lessons learned from JCSDA.
- In working toward Open Source Science, NASA should ensure that data and computing are co-located – where users can log in (e.g., into a cloud environment) and work with the data locally rather than download it. ESD should also work toward greater collaboration with other centers/agencies implementing commercial satellite centers.

Findings and Recommendations: Looking Ahead: Digital Twins and ESO Data Integration

- **Finding**: The committee recognizes the importance of Digital Twins (DTs) and supports the activities being developed at NASA, recognizing that NASA and its partners generate most of the data needed to ensure digital twin efforts in Earth Science are successful.
- **Recommendation**: In developing the Digital Twin framework, ESD should clearly define and prioritize application scenarios to ensure focused resource allocation and alignment with strategic objectives, engage with the broader community to ensure the framework is innovative and stays at the forefront of digital twin advancements, and ensure 1) co-location of DTs and the data systems they access (critical to integrating observations, data assimilation, and modeling, into DTs), and 2) that DT outputs (e.g., observations and forward modeling capabilities) include uncertainty quantification and are provided with rigorous education and communication about those uncertainties.
- **Finding**: The committee recognizes the value of thinking holistically about the ESO missions and in planning, where possible, for known future data integration opportunities.
- **Recommendations**: Addressing NASA ESD's ES2A objectives in the coming years will require leveraging the entire global observing system. NASA R&A activities should therefore accommodate the use of data from across the international portfolio of Earth observations, along with those from NASA assets. In so doing, NASA should be careful about overextending resources or being over-prescriptive about data integration and should leave adequate room for organic evolution. Though the committee did not have sufficient time to discuss specific multi-sensor products or procurement approaches, we recommend that ESD focus on the Open Science computing approach and work to bring ESO data together (e.g., in the cloud), organized by observation category, with accessible interfaces to query data, test data fusion approaches, and thus push the data to their limits organically. The committee also recommends that NASA include a competed aspect to data integration to ensure diversity of ideas and a broad scope of intellect.
- **Finding**: Multiple communication layers exist at different centers, leading to potential information silos. ESD communications is being created to streamline the storytelling process.
- **Recommendation**: ESD present at a future ESAC meeting on the needs and status of computing at ESD, including but not limited to high performance computing, open-source science, cloud computing, data centers, and communications, and plans to address any shortfalls in these areas.



National Aeronautics and Space Administration

NASA

EARTH FLEET

Key

- International Partners
- U.S. Partner
- ISS Instrument
- JPSS Instrument
- Cubesat
- Launch Date TBD
- Earth System Observatory Mission
- (Pre) Formulation
- Implementation
- Operating
- Extended

Invest/CubeSats

- NACHOS 2022
- CTIM 2022
- NACHOS-2 2022
- MURI-FD 2023
- SNOOPI* 2024
- HYTI* 2024
- ARGOS* 2024

JPSS Instruments

- OMPS-LIMB 2022
- LIBERA 2027
- OMPS-LIMB 2027
- OMPS-LIMB 2032

ISS INSTRUMENTS

MISSIONS

NASA earth

04.10.2024

Upcoming ESAC Meetings

- GPRAMA annual report review, October 2024 (virtual)
- 2025 meeting: TBD

National Aeronautics and Space Administration

Planetary Science Advisory Committee (PAC) Report to NAC Science Committee

Hope Ishii, Chair

October 9, 2024

PAC Members

- Hope Ishii† (Chair), University of Hawai‘i at Mānoa
- Shannon Curry* (Deputy Chair), University of Colorado, Boulder
- Katharine Robinson* (Executive Secretary), NASA Headquarters
- Walter Kiefer†, Lunar and Planetary Institute, USRA
- Lisa Danielson†, Los Alamos National Laboratory
- D’Arcy Meyer-Dombard†, University of Illinois
- Tyler Robinson†, Northern Arizona University
- John Grant, Smithsonian Institution
- Kandi Jessup, Southwest Research Institute
- Brent Barbee, Goddard Space Flight Center
- Louise Prockter, Johns Hopkins University Applied Physics Laboratory
- David Murrow, Space Connections, LLC
- Deborah Woods, MIT Lincoln Laboratory
- Morgan Cable, Jet Propulsion Laboratory

† term ends 12/31/2024, *new role since last NAC SC meeting

The PAC meets 3x / year + 1x/year for GPRAMA assessments

- spring (Feb/Mar, hybrid)
- summer (Jun/Jul, hybrid)
- winter (Nov/Dec, virtual)

2 PAC meetings since PAC last presented at a NAC SC meeting

- **July 9-11, 2024 – summer PAC Meeting (hybrid at NASA HQ)**
- **Sept 21, 2024 – PAC GPRAMA discussion (virtual)**

Next PAC meeting

- **November 11-12, 2024 – winter PAC meeting (virtual)**

Charter; membership; meeting agendas, minutes, findings, presentations, minutes

https://science.nasa.gov/researchers/nac/science-advisory-committees/pac/

PAC GPRAMA Discussion

virtual online
September 20, 2024

- Discussed and selected evidence for, and voted on, NASA performance goals for the GPRAMA Science Evaluation (Government Performance and Results Act (GPRA) Moderniation Act (GPRAMA), 2010)

PERFORMANCE GOALS assessed by PAC	Science Progress Rating
1.2.3 NASA shall demonstrate progress in exploring, observing, and understanding objects in the Solar System in order to understand how they formed, operate, interact, and evolve.	
1.2.5 NASA shall demonstrate progress in improving understanding of the origin and evolution of life on Earth to guide the search for life elsewhere, exploring and finding locations where life could have existed or could exist today, and exploring whether planets around other stars could harbor life.	
1.2.7 NASA shall demonstrate progress in identifying, characterizing, and predicting objects in the Solar System that pose threats to Earth or offer resources for human exploration.	

 Expectations fully met

 Some significant shortfalls, some worthy advancements

 Major shortfalls uncompensated by positive results

PAC Meeting

NASA Headquarters, Washington, D.C.
July 9 – 11, 2024

- Topics presented and discussed
  - **Planetary Science Division Update** *(Gina DiBraccio* (Acting PSD Director) and Shannon Fitzpatrick)*
  - **PSD R&A Update** *(Kathleen Vander Kaaden and Delia SantiagoMaterese)*
  - **Assessment/Analysis Group (AG) Updates** *(AG Chairs, co-Chairs and Liaisons)*
  - **EDIA Cross-AG Working Group update** *(Julie Rathbun and Kas Knicely)*
  - **DSN Usage Update** *(Philip Baldwin)*
  - **MSR IRB Response Team** *(Paul Hertz)*
  - **Mars Exploration Program** *(Eric Ianson and Tiffany Morgan)*
  - **Moon-to-Mars Architecture Report** *(Julie Grantier and Jacob Bleacher)*
  - **Artemis Science Planning Update** *(Cindy Evans, Barbara Cohen, Juliane Gross)*
  - **ESSIO/Lunar Update** *(Joel Kearns and Sarah Noble)*
  - **Lunar Reference Frame Update** *(Robin Fergason)*
  - **Astrobiology Update** *(David Grinspoon and Becky McCauley Rench)*
  - **Research Coordination Network (RCN) Updates** – **NOW** *(Chris German)*, **NExSS** *(Ofer Cohen)*

*new role since last NAC SC meeting

Highlighted March 2024 PAC Meeting Finding and Recommendation and PSD Response (abbreviated)

Finding 4: The Deep Space Network (DSN) is critical in planetary science missions and radar science, and deferred maintenance and significantly increased demand of upcoming planetary and crewed Artemis missions are major stressors. Even with planned facilities and upgrades underway, **DSN's capacity is likely to be insufficient to meet both Artemis and Planetary Science needs**. Recognizing budgetary constraints across the Agency, the PAC requested more details on strategy for DSN resource allocation, mitigation, and policies for mission prioritization (US and international) in competition for resources.

PSD Response:

- SMD POC assigned to communicate with DSN; SCaN Working Group and Spectrum Working Group - with reps from each SMD Division – meet regularly about mission specific concerns, pass to SCaN via the SMD POC.
- SMD is increasing dialogue about DSN concerns for missions at the monthly Flight Program Review (FPR).
- Required SCaN/DSN review section at KDP-C for each mission.
- Agency-level DSN Tiger Team, including SMD SCaN POC, meets weekly about DSN maintenance and capabilities issues, bandwidth and prioritization issues for SMD missions, and potential impacts and conflict resolution for Artemis DSN usage. This team reports directly to the Space Operations Mission Directorate AA at the quarterly SCaN Board of Directors, which SMD's AA co-chairs with the SOMD AA.
- We are seeing issues being resolved and future planning is more detailed and accurate. A unified voice (from SMD and SOMD) is also better communicating the need for additional funding for SCaN to senior Agency leadership.

PSD is optimistic that the increased spotlight on DSN issues to senior Agency leadership will result in fruitful changes and risk mitigation for our SMD and Planetary missions.

Full text: https://science.nasa.gov/researchers/nac/science-advisory-committees/pac/

Highlighted July 2024 PAC Meeting Findings (abbreviated)

- *Finding 3:* **DSN is a critical resource for planetary missions, but projected demand greatly outstrips current and planned capacity.** DSN should continue to communicate clearly with stakeholders on process and guidelines for prioritizing requests as a function of mission class, operational needs, and scientific return. The PAC heard that NASA's Space Communications and Navigation (SCaN) program's plan for better matching planned capacity to projected demand involves future missions designed conserve DSN resources, but those missions need advance understanding of those design practices.
  - *Recommendations:* (1) The PAC recommends that PSD, SMD and SCaN develop resources to help major stakeholders, including mission PIs and mission providers, incorporate best practices for optimum utilization of the already strained DSN resources. Strategic planning could more efficiently leverage DSN capacity. The PAC also suggests PSD consider including review of proposed missions' DSN utilization plans as part of the proposal process and/or review current missions' DSN utilization plans to identify opportunities for optimization. (2) The PAC recommends **PSD strongly advocate for funding support** with other mission directorates for critical maintenance of current DSN infrastructure and development of additional capacity to meet projected needs.

Full text: https://science.nasa.gov/researchers/nac/science-advisory-committees/pac/

Highlighted July 2024 PAC Meeting Findings (abbreviated)

- *Finding 3:* **DSN is a critical resource for planetary missions, but projected demand greatly outstrips current and planned capacity.** DSN should continue to communicate clearly with stakeholders on process and guidelines for prioritizing requests as a function of mission class, operational needs, and scientific return. The PAC heard that NASA's Space Communications and Navigation (SCaN) program's plan for better matching planned capacity to projected demand involves future missions designed conserve DSN resources, but those missions need advance understanding of those design practices.
  - *Recommendations:* (1) The PAC recommends that PSD, SMD and SCaN develop resources to help major stakeholders, including mission PIs and mission providers, incorporate best practices for optimum utilization of the already strained DSN resources. Strategic planning could more efficiently leverage DSN capacity. The PAC also suggests PSD consider including review of proposed missions' DSN utilization plans as part of the proposal process and/or review current missions' DSN utilization plans to identify opportunities for optimization. (2) The PAC recommends **PSD strongly advocate for funding support** with other mission directorates for critical maintenance of current DSN infrastructure and development of additional capacity to meet projected needs.
- *Finding 1:* Mars Sample Return (MSR) faces nearly intractable budget and schedule problems, and NASA must take advantage of all means of support. Although Moon to Mars (M2M) capitalizes on momentum for human exploration of Mars, many commonalities between M2M and robotic precursors, including MSR, are not clearly defined (e.g. first Mars round trip, first launch from another planet, technology development). The PAC finds that neglecting linkages between robotic and human exploration, including the first demonstration of a round trip to Mars by the MSR program, is detrimental to both programs.
  - *Recommendation:* The PAC recommends that PSD produce MSR program documentation, in a format digestible by the M2M program, that contains requirements and outcomes that may benefit the M2M Inspiration, Science, and National Posture objectives. The PAC recommends PSD works with the M2M program to explicitly include the many benefits of MSR in its architectures, thus utilizing the resources and visibility of the Human Exploration Program to benefit MSR. Additionally, the PAC respectfully suggests that **MSR be elevated to an agency-level priority** in recognition of A) the resources being allocated by other spacefaring nations to returning samples from the red planet, and B) the relationship between our National Posture objectives and the extraordinary achievement of becoming the first to return samples from Mars.

Full text: https://science.nasa.gov/researchers/nac/science-advisory-committees/pac/

Highlighted July 2024 PAC Meeting Findings (abbreviated)

- *Finding 4:* The PAC recognizes the continuing **critical importance of the ANSMET (Antarctic Search for Meteorites) Program to planetary science research and missions** . Recovered meteorites are samples of planetary bodies, recovered at low cost compared to sample return missions. Meteorites motivate and provide key information for current and planned missions. ANSMET has recovered >23,000 meteorites, many from Mars and the Moon, providing a continuous (annual) supply. ANSMET is funded by NASA but relies on logistical support of Antarctic field activities by NSF. The COVID-19 pandemic resulted in the cancellation of the 2020-21, 2021-22 and 2022-23 ANSMET field seasons. The PAC appreciates NSF's logistical support of the 2023-24 season. NSF halted support for the 2024-25 season, and it is unclear if NSF will support the 2025-26 season.
  - *Recommendation:* The PAC encourages NASA to **re-engage NSF logistical support for ANSMET and, failing that, to explore alternative logistical support to ensure continuity of the ANSMET Program**.

Full text: https://science.nasa.gov/researchers/nac/science-advisory-committees/pac/

Highlighted July 2024 PAC Meeting Findings (abbreviated)

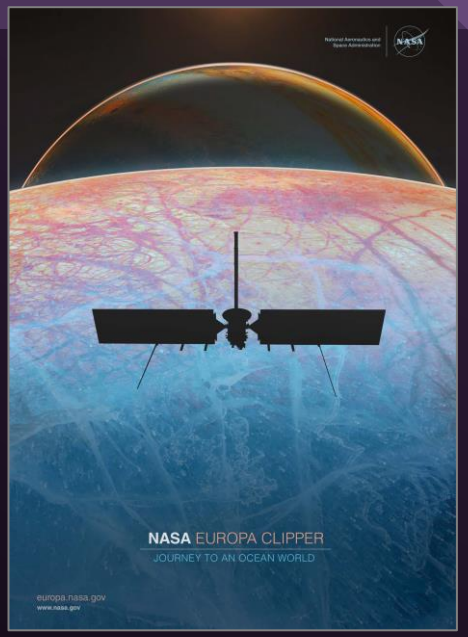
- *Finding 4:* The PAC recognizes the continuing **critical importance of the ANSMET (Antarctic Search for Meteorites) Program to planetary science research and missions** . Recovered meteorites are samples of planetary bodies, recovered at low cost compared to sample return missions. Meteorites motivate and provide key information for current and planned missions. ANSMET has recovered >23,000 meteorites, many from Mars and the Moon, providing a continuous (annual) supply. ANSMET is funded by NASA but relies on logistical support of Antarctic field activities by NSF. The COVID-19 pandemic resulted in the cancellation of the 2020-21, 2021-22 and 2022-23 ANSMET field seasons. The PAC appreciates NSF's logistical support of the 2023-24 season. NSF halted support for the 2024-25 season, and it is unclear if NSF will support the 2025-26 season.
  - *Recommendation:* The PAC encourages NASA to **re-engage NSF logistical support for ANSMET and, failing that, to explore alternative logistical support to ensure continuity of the ANSMET Program**.

- *Finding 5:* **Nuclear fission-based power and propulsion technologies have a singular potential to increase our space exploration capabilities**, including significant reductions in flight time, increases in deliverable mass for missions to outer planets, melt probes for ocean worlds investigations and lunar night-time survival. Early investments and continuous support could mature these technologies soon enough to infuse them into missions targeting the next decadal time frame. The PAC is excited about these possibilities and encourages NASA to continue supporting ongoing industry efforts to develop nuclear fission power systems for both terrestrial and lunar systems. The PAC also expresses support of nuclear power technology development efforts at other government agencies. *No recommendation.*

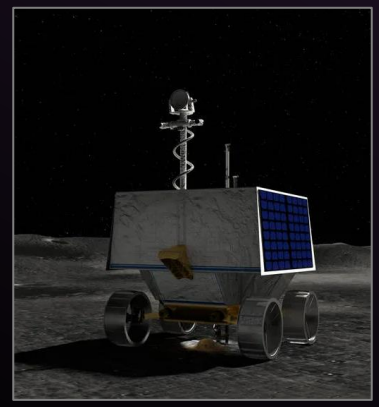
Full text: https://science.nasa.gov/researchers/nac/science-advisory-committees/pac/

Requested topics

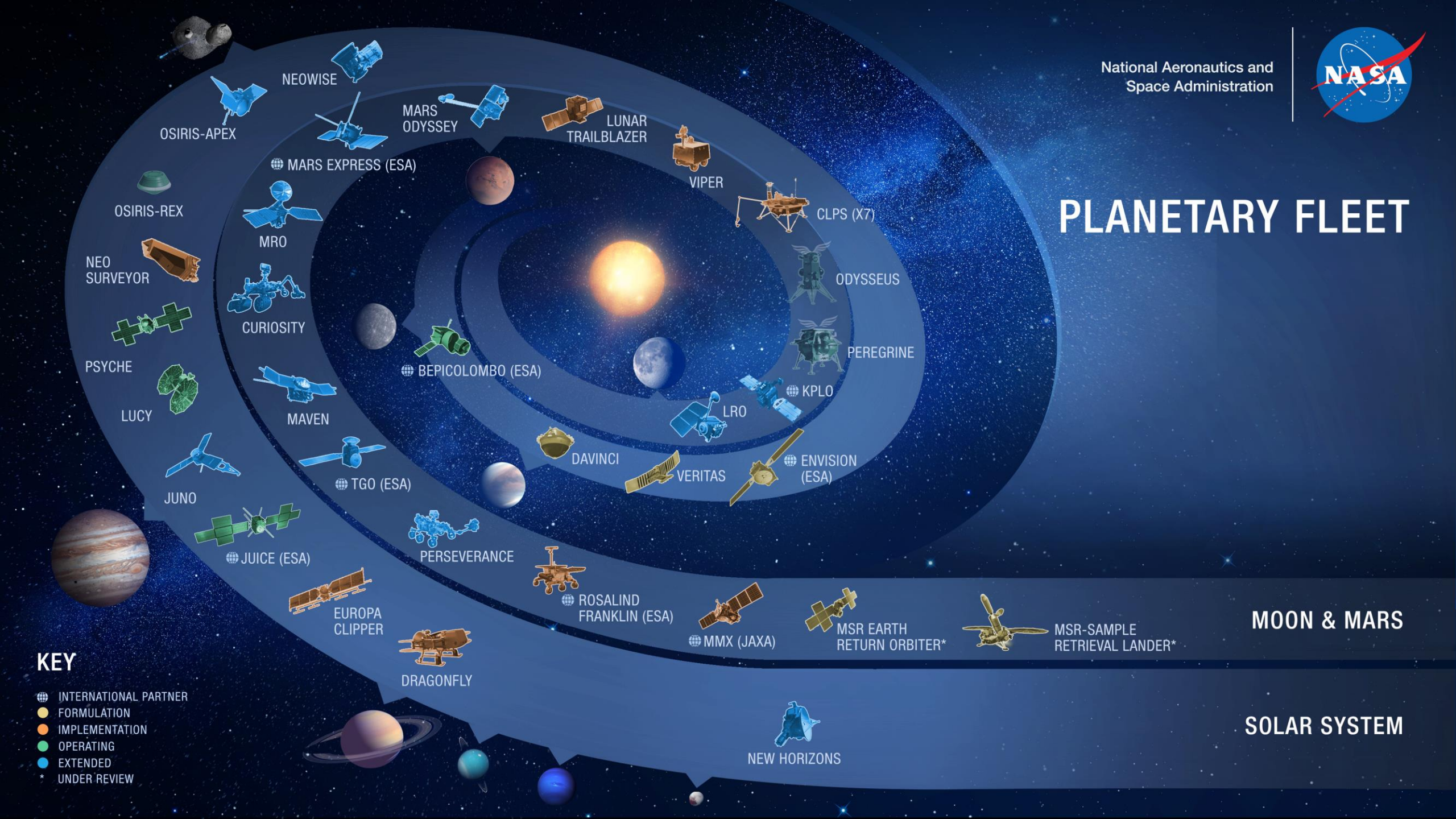
(everything may not fit in this meeting!)



- PSD update
- R&A update
- AG reports



- Mars Sample Return and Mars Exploration Program update
- Clipper and lessons learned about vendor MOSFET issue
- ESSIO/Lunar, including Moon 2 Mars and CLPS
  - VIPER update
- Dragonfly, including cost concerns
- SIMPLEX program budget and cost caps
- EnVision, including cost concerns
- NASEM report on NASA Mission Critical Workforce, Infrastructure, and Technology, particularly DSN
- PSD status with respect to the NASEM report on IDEA
- NSSC communication issues (Finding #)


National Aeronautics and Space Administration
NASA
PLANETARY FLEET
NEOWISE
OSIRIS-APEX
MARS ODYSSEY
LUNAR TRAILBLAZER
MARS EXPRESS (ESA)
VIPER
OSIRIS-REX
CLPS (X7)
MRO
NEO SURVEYOR
ODYSSEUS
CURIOSITY
PEREGRINE
PSYCHE
BEPICOLOMBO (ESA)
KPLO
LUCY
LRO
MAVEN
DAVINCI
ENVISION (ESA)
TGO (ESA)
VERITAS
JUNO
JUICE (ESA)
PERSEVERANCE
ROSALIND FRANKLIN (ESA)
EUROPA CLIPPER
MMX (JAXA)
MSR EARTH RETURN ORBITER*
MSR-SAMPLE RETRIEVAL LANDER*
MOON & MARS
DRAGONFLY
NEW HORIZONS
SOLAR SYSTEM
KEY
INTERNATIONAL PARTNER
FORMULATION
IMPLEMENTATION
OPERATING
EXTENDED
* UNDER REVIEW

- **FISCAL YEAR 2025**

Planetary Science Budget Priorities

Explore/Innovate/Partner/Inspire

Successfully complete confirmed high-priority missions including **Europa Clipper, NEO Surveyor, Dragonfly**

Support **international partnerships:** Juice, MMX, Rosalind Franklin Mission, Envision

Ensure Decadal-recommended science investigations are included in **Artemis** campaign; support stable cadence of future CLPS deliveries to the lunar surface

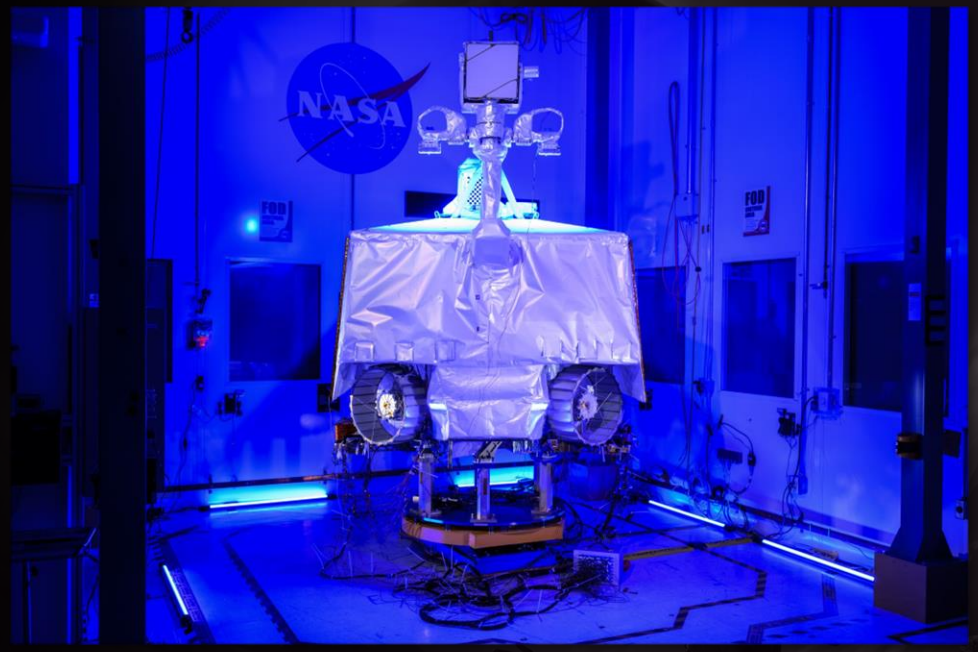
Support Planetary Science **research** community to ensure continued scientific discovery from NASA mission data

Dragonfly

- In November 2023, the Agency postponed formal confirmation of mission until release of FY25 President's Budget Request (PBR)
- With the release of FY24 PBR Dragonfly was confirmed on April 16, 2024
  - Mission has proceeded into Phase C
  - Launch Readiness Date: July 2028
- Project is now working towards Mission Critical Design Review (CDR) in April 2025
  - Subsystem CDRs are ongoing
- Launch Vehicle Procurement is underway, and selection is on schedule for Fall 2024

VIPER

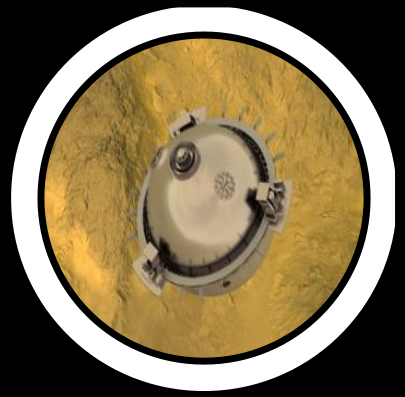
- NASA announced its intent to discontinue the VIPER mission on July 17, 2024
  - Due to overall SMD funding constraints, future budget risks, and Astrobotic lander delays
- Expressions of interest in conducting VIPER mission concepts from potential partners were requested and received from a range of parties (from domestic companies and international agencies to backyard/garage enthusiasts)
- Subsequent Request for Information (RFI) was released to domestic entities
  - NASA formed a committee to assess information
  - Report provided to senior SMD and Agency leadership; A-Suite will determine best path forward
- In parallel: NASA reached out to international partners to gauge interest in partnering with NASA to complete VIPER mission
  - Several agencies responded; NASA expects to enter discussions with the agencies to determine feasibility



VIPER budget sits within Lunar Discovery and Exploration (LDEP) line of PSD budget

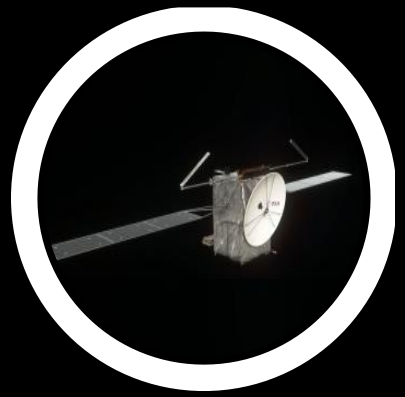
Slide from Gina DiBraccio / Shoshana Wieder, Sept 2024

Back to Venus



DAVINCI (2031/2032)

Deep Atmosphere Venus Investigation of Noble Gases, Chemistry, and Imaging



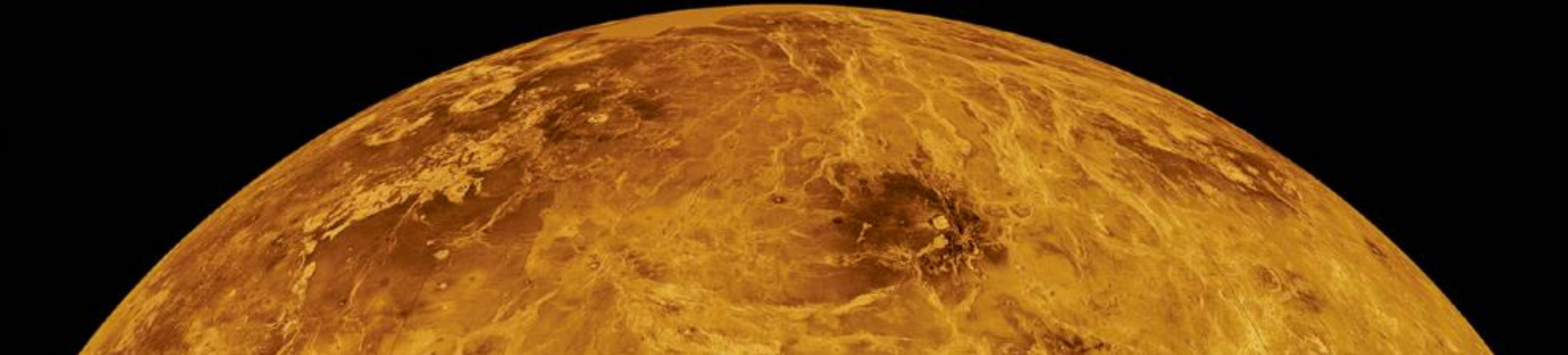
Envision (2031)

ESA Medium-Class Mission

NASA contribution includes VenSAR (Synthetic Aperture Radar)

VERITAS (2031/2032)

Venus Emissivity, Radio Science, InSAR, Topography, & Spectroscopy



Slide from Gina DiBraccio / Shoshana Wieder, Sept 2024

Europa Clipper

First launch opportunity: October 10, 2024, 12.31 pm EDT

Jupiter Orbit Insertion: April 2030

Artist's Concept

Additional Slides

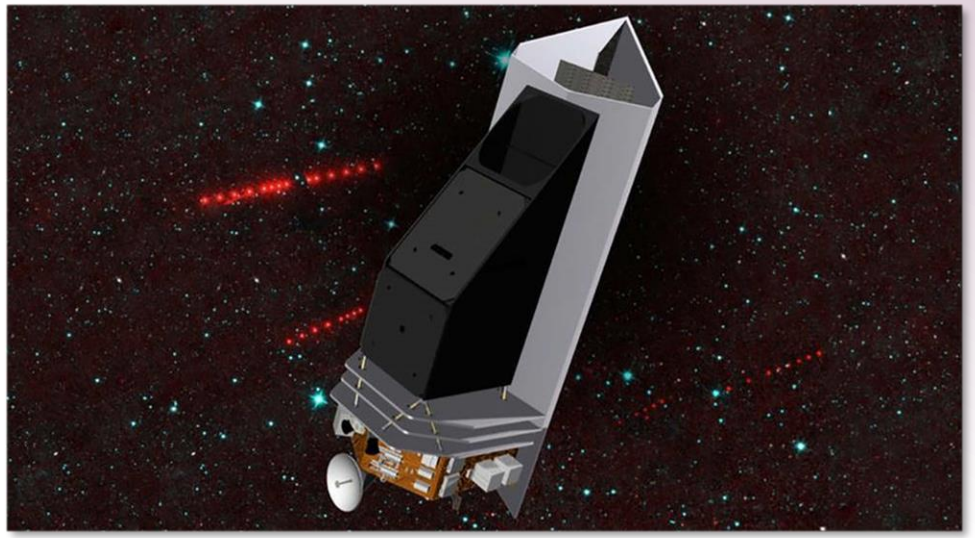
- PSD top leadership change
  - In May 2024, Dr. Lori Glaze announced she was leaving her role as PSD Director for a 6-mo detail as the Acting Deputy Associate Administrator (AA) for Exploration Systems Development Mission Directorate (ESDMD).
  - Dr. Gina DiBraccio, formerly the Deputy Director of the Heliophysics Science Division at GSFC, has taken on the role of Acting PSD Director.
  - For other PSD leadership changes, see https://science.nasa.gov/about-us/org-chart/

Lori Glaze, ESDMD Deputy AA (Acting)

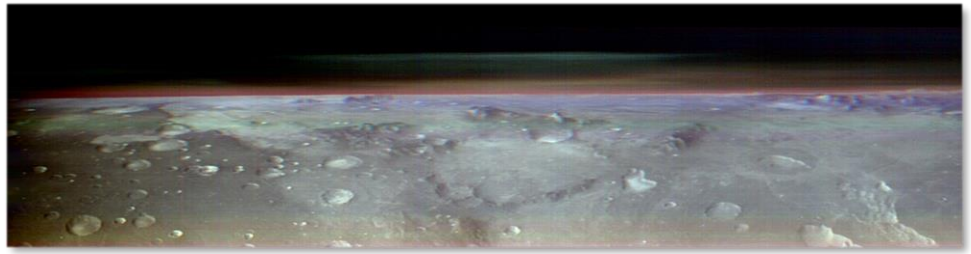
Gina DiBraccio, PSD Director (Acting)

FISCAL YEAR 2025

Planetary Science Highlights



Artist conception of the NEO Surveyor spacecraft. Image credit: NASA/JPL-Caltech

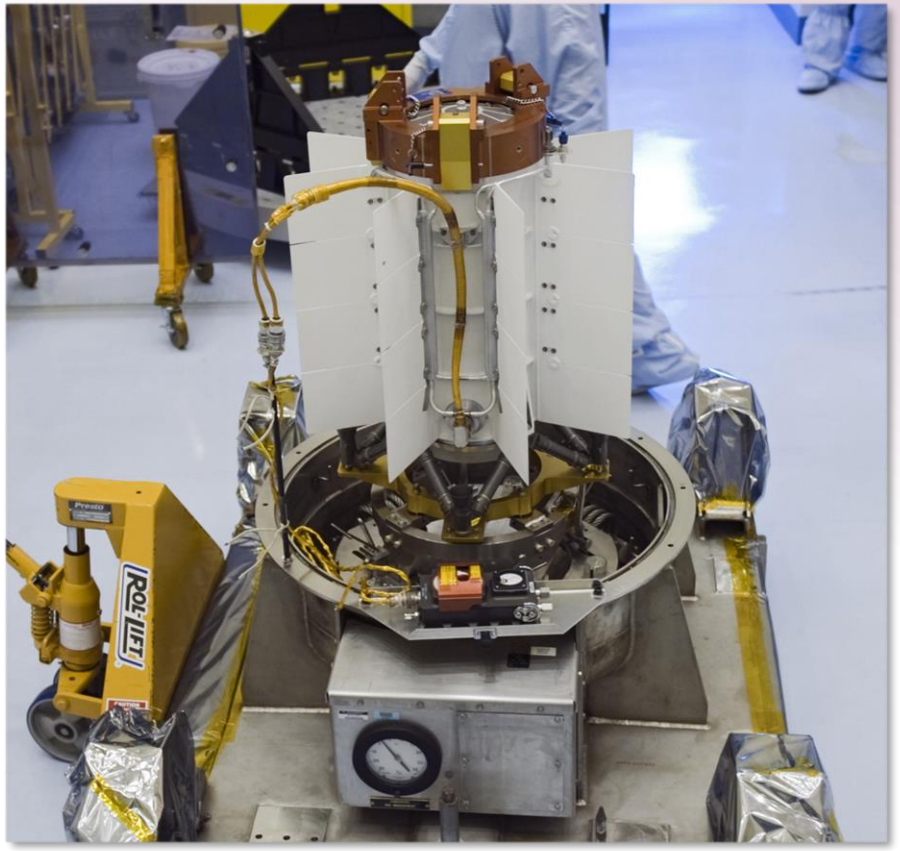


This view of Mars was captured by NASA's Odyssey orbiter using its THEMIS camera. It combines three channels of infrared data that highlight water-ice clouds and dust in the atmosphere. Image credit: NASA/JPL-Caltech/ASU

- **Mars Sample Return** paused in FY24 while architecture studies are completed; FY25 budget request is $200M
- Supports launch of **Europa Clipper** (Oct 2024) and **NEO Surveyor** (2027)
- Supports **Dragonfly** mission for 2028 LRD, confirmed on April 16
- Three missions to study Venus: **DAVINCI**, **VERITAS** (both to launch in 2031–32 timeframe) and contributions to ESA **EnVision**
- **Mars Exploration Program** supports ongoing operation of 5 missions at Mars, including Perseverance and MSL, and new investments in technology to enable future Mars missions
- Robust **Lunar Discovery and Exploration Program** which includes:
  - Two **CLPS** awards per year in most years
  - Annual **PRISM** calls for instruments
  - Artemis Science instruments, including handheld instruments for astronauts and the lunar terrain rover
  - Lunar Reconnaissance Orbiter operations
  - Support **Lunar Trailblazer** for planned launch in FY 2025
  - VIPER Continuation/Termination review took place and NASA announced its intent to discontinue the mission

FISCAL YEAR 2025

Planetary Science Highlights



An RPS MMRTG. This unit is currently installed and operating on the Curiosity Rover. Image Credit: NASA/DOE

- The next **New Frontiers, Discovery, and SIMPLEx** AOs expected to be released no earlier than 2026
- New **Planetary Technology** strategy and project, to provide integrated technology development for future planetary science missions
- Pre-formulation studies of the Decadal-Survey-recommended Uranus Orbiter and Probe mission will begin in the current budget horizon
- Investments in **Open Source Science** to enhance transparency, inclusivity, accessibility, and reproducibility in publicly funded scientific research.
    - This project also supports SMD's transition to cloud computing services
- **Radioisotope Power Systems** program investments in technology, to enable successful trips to distant solar system destinations with harsh environments; includes development of the Dragonfly MMRTG
- **Planetary Data System** data archives, which now span more than 50 years of NASA-funded research, and will expand to include ground-based observations of Near-Earth objects

March 2024 PAC Meeting Finding with Recommendation and PSD Response (abbreviated)

Finding 3: The PAC appreciates efforts to implement compelling science in the Artemis architecture under the Moon-to-Mars program and to proactively study science objectives in future Mars exploration architectures. The PAC recommends **regular and ongoing collaboration among scientists, engineers and technologists to instantiate compelling science as a pillar of the Moon-to-Mars program** (via individual Artemis missions, science advisory groups, science teams, etc.) The PAC requested a briefing at the summer or fall PAC meeting.

PSD Response:

- Boards co-chaired by, or with polling membership from, SMD, ESDMD, SOMD and STMD, ensure science needs are met by the proposed implementation/execution paths and are factored into technology development investments
- …regularly solicit input from the science and technology communities …
- ESDMD DAA for Strategy and Architecture and the Chief Exploration Scientist attended July 2024 PAC meeting and described these processes.

Full text: https://science.nasa.gov/researchers/nac/science-advisory-committees/pac/

March 2024 PAC Meeting Findings without Recommendations (abbreviated)

Finding 1:

- The PAC reaffirms our prior finding from November 2023 in strong support of the priorities and budget guidelines of the Origins, Worlds, and Life Decadal Survey (OWL). We also note that support was expressed unanimously by the community Assessment/Analysis Groups (AGs) for the OWL priorities. *No recommendation.*

Finding 2:

- The PAC expresses sincere gratitude to PSD and SMD leadership for advocacy ultimately resulting in the NASA Administrator's certification to Congress for a limited exemption under the Wolf Amendment that allows for access to Chang'e 5 samples by NASA-funded researchers. The community recognized the uniqueness of the Chang'e 5 mission samples as a young mare basalt far from previous collection sites and holding the potential to dramatically change our understanding of solar system volcanic and impact history. …NASA-funded researchers have a strong interest in studying these samples but understand that their collaboration with the People's Republic of China (PRC) is constrained by the Wolf Amendment, a Congressional limitation prohibiting bilateral exchanges between NASA-funded scientists and scientists and institutions in the PRC. The PAC recognizes both the work by NASA to achieve the exemption along with the potential for scientific advancement enabled by access to the samples via NASA awards. *No recommendation.*

Finding 5:

- The PAC appreciates the efforts of ExoPAG in proactively taking steps to create productive and longstanding relationships between many disciplines, including the astrophysics and planetary science communities. The PAC is supportive of the ongoing ExoPAG efforts in seeking ways to strengthen these relationships across multiple avenues of engagement, including invited speakers, virtual direct messaging, and thoughtfully scheduled workshops. The PAC looks forward to the forthcoming community review paper that will identify overlaps and synergies among multiple disciplines and link the science initiatives of the Astro2020 and Origins, Worlds and Life 2023 decadal surveys. *No recommendation.*

Full text: https://science.nasa.gov/researchers/nac/science-advisory-committees/pac/

July 2024 PAC Meeting Findings and Recommendations (abbreviated)

Finding 2

- The PAC supports NASA's investments in workforce training and pipeline expansion. Programs like the NASA Early Career Awards, Here to Observe (H2O), InSightSeers, and PI Launchpad that encourage, amplify and train the pipeline of aspirational scientists and mission-PIs are especially applauded. NASA leadership has communicated that inclusion is a core NASA value and beneficial to NASA's ability to recruit and engage the best talent, an outcome that directly impacts the agency's ability to achieve national priorities. The PAC has been informed that required inclusion plans, piloted in over a dozen programs in ROSES-2022 through ROSES-2024, are likely to become a required component in (mission and/or R&A) proposals to PSD programs in the future. As such, training on inclusion plan development and implementation is valuable for all career stages. Access to this type of training for those early in their careers, in particular, will enable them to be better prepared to operate in alignment with NASA's core values throughout the arc of their careers.
- *Recommendation:* The PAC recommends that PSD leverage existing training forums to provide guidance to the community on inclusion plan development and implementation. Examples of existing training forums include (mission-focused) PI Launchpad, early career training workshops, NASA supported networking/mentoring events, and various online IDEA and proposal forums and resource repositories. It is important that NASA continue to maintain and utilize all available resource mechanisms (town halls, weblinks, etc.) to explain NASA's proposal expectations and policies and to provide guidance on the best ways to meet NASA inclusion plan goals and metrics. Additionally, we emphasize that it is important that PSD training mechanisms are available to all members of the community at all career stages.

Note: The PAC aims for consensus with Findings, but there remained a dissenting member for this Finding.

Full text: https://science.nasa.gov/researchers/nac/science-advisory-committees/pac/

Finding 6

- The community has experienced a considerable amount of uncertainty over the past 18 months regarding the cadence at which specific calls for CLPS/Artemis instruments would be released, and in which order. ROSES 2023 included elements for PRISM, SALSA PRISM, A3DI, A4DI, and LTV Instruments. Of these, only A3DI was ultimately solicited through ROSES 2023 with the remaining elements carried over to ROSES 2024. This is despite community advisory presentations that SALSA PRISM would be solicited through ROSES 2023 (with PRISM-4 deferred to ROSES 2024). While public communication since September 2023 has consistently maintained that SALSA PRISM will be the next solicited opportunity, the remaining opportunities have changed order repeatedly. This, combined with limited (and inconsistent) information about the expected timing, makes it challenging for the community to plan their work and respond to these calls effectively. The community reports that institutions have changed their pre-proposal investments multiple times based on the publicly available information. The PAC finds that a more stable timeline for these calls from ESSIO and release of calls in the order in which they are originally proposed would benefit the planetary science community.
  No recommendation.

Finding 7

- The PAC has heard a number of community concerns that NASA Shared Services Center (NSSC) communication can be inconsistent, unreliable, and sometimes vague with respect to when awards will be made, and the PAC finds that what seems to be predominantly one-way communication is not serving the community needs well. In some cases we have heard that awards are made later than promised and action is only taken to speed things when repeatedly prompted. NSSC tells the community that any action (no cost extensions (NCEs), awards, funding, etc.) takes 45-60 days to process but we hear that the majority of these have been taking at least 60 days and sometimes longer. Transfer of awards between institutions is a particularly long and painful process. Requirements are very detailed and, once paperwork from both institutions has been submitted, it often takes months before notification if something is missing or incorrect. These are generally very minor issues, but they can lead to a large administrative burden and can cause huge delays in getting funding de-obligated from one institution and then re-obligated to another. Given the recent move by NSSC to rigorously hold the planetary community to NCE deadlines, we look forward to hearing what action PSD can take to hold NSSC to their own promised deadlines for awards and to better streamline their processes to reduce the burden on PIs and their institutions.
  No recommendation

Full text: https://science.nasa.gov/researchers/nac/science-advisory-committees/pac/

BREAK

Committee will reconvene at 1pm ET

National Aeronautics and Space Administration

Discussion Panel: Climate Change and Earth System Science Strategy

Kate Calvin, Chief Scientist and Senior Climate Advisor, NASA

Karen St. Germain, Earth Science Division Director, NASA SMD

With special guest:
Waleed Abdalati, NASA Advisory Council

National Aeronautics and Space Administration

NASA earth

NASA Climate Change and Earth System Science Strategy

Panel Discussion | NAC Science Committee

Karen St. Germain, PhD
Director
Earth Science Division

Kate Calvin, PhD
Chief Scientist and Senior Climate Advisor

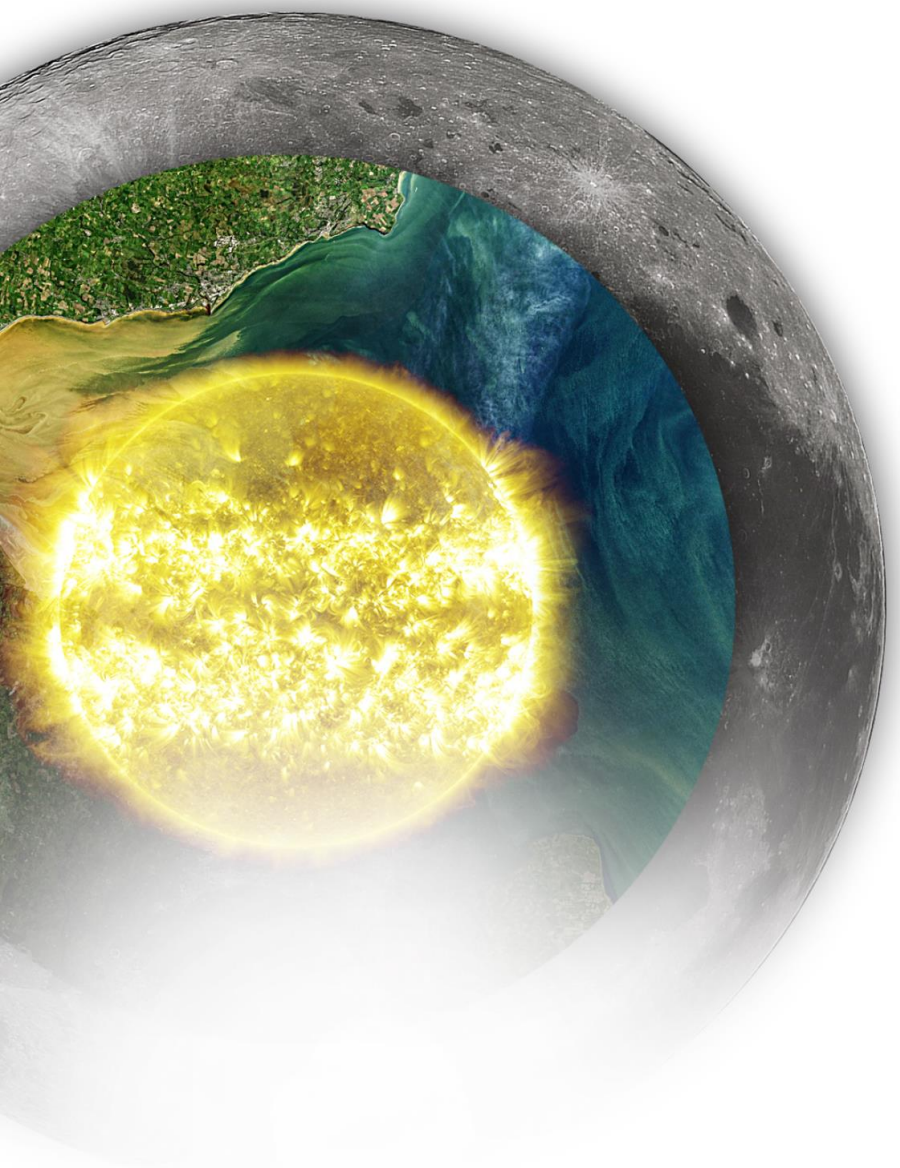
Climate Strategy Overview

NASA's climate strategy provides a brief synopsis and overview of our climate portfolio, along with recommendations to better integrate climate across NASA. This will help to better inform and serve the public and the scientific and space communities, in regards to climate change.

NASA's climate strategy outlines four major priorities for the agency to help with this coordination and integration:

- Innovate
- Inform
- Inspire
- Partner

Progress Towards Achieving NASA's Climate Strategy



Innovate

New Earth observing missions

Sustainable aviation

Inform

Availability and accessibility of data and tools

Earth Information Center

Inspire

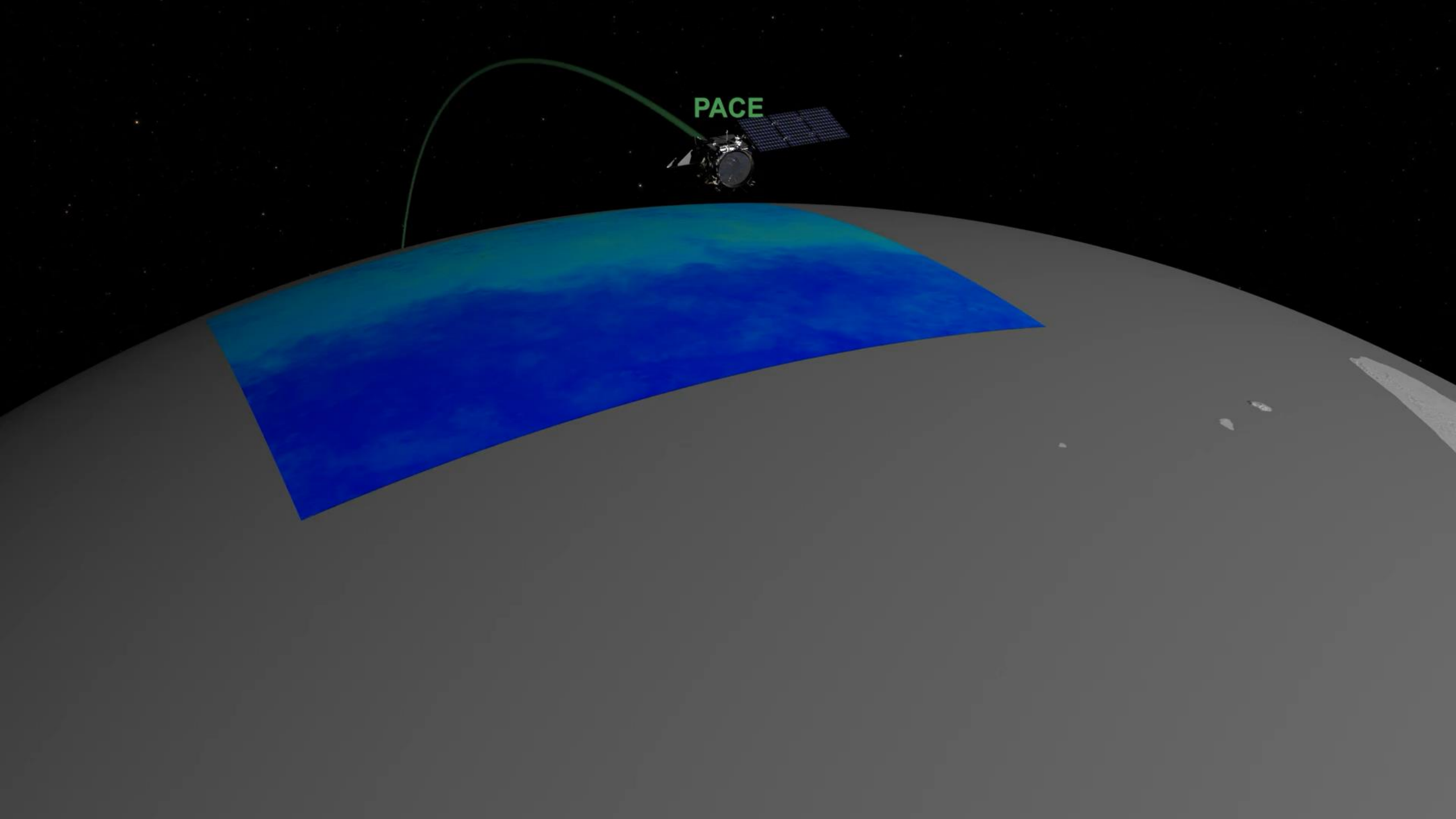
Communication

Climate literacy and education

Partner

U.S. government

Private sector


PACE

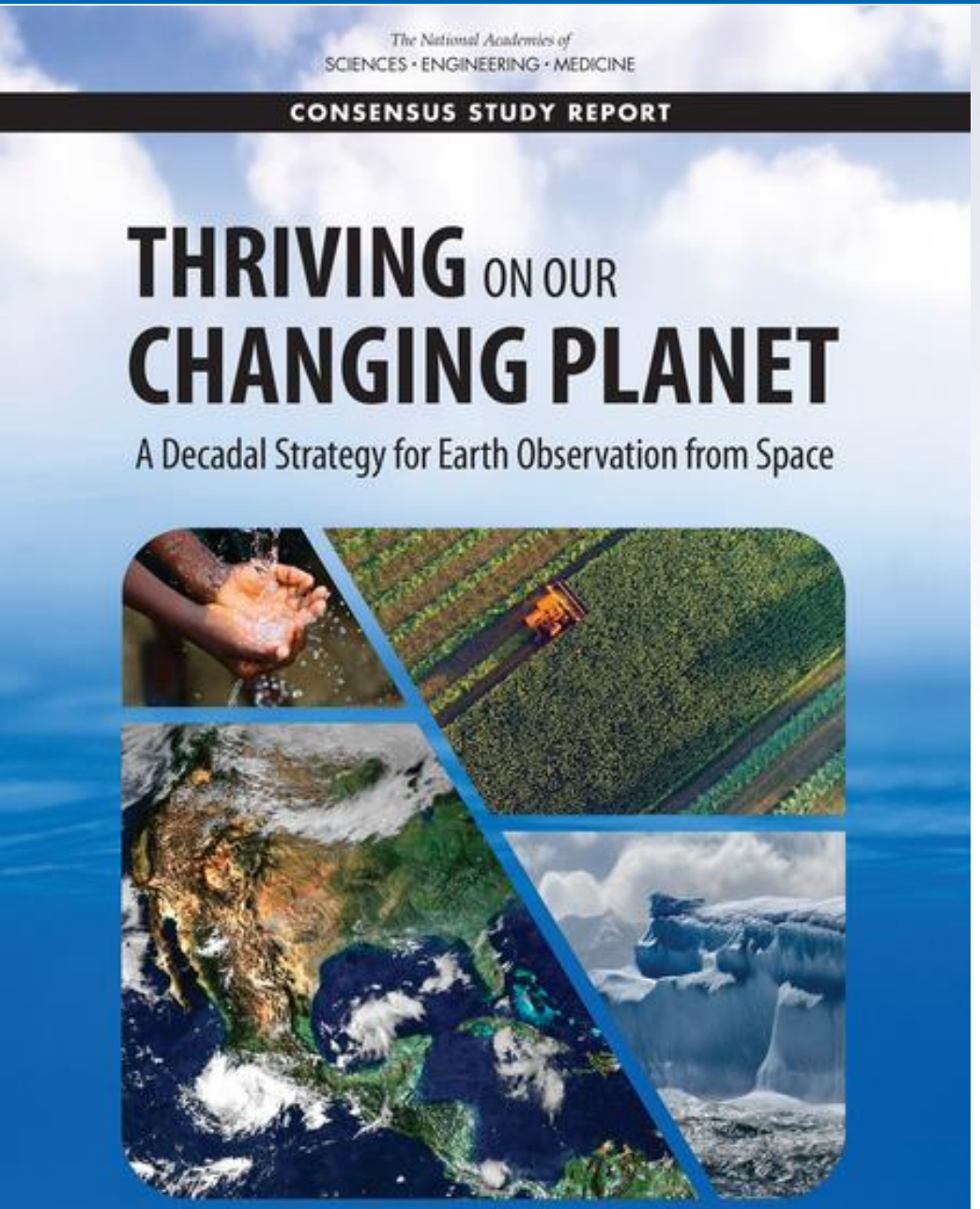
Earth Information Center

National Aeronautics and Space Administration

CLIMATE 101

U.S. Greenhouse Gas Center

Uniting Data and Technology to Empower Tomorrow's Climate Solutions

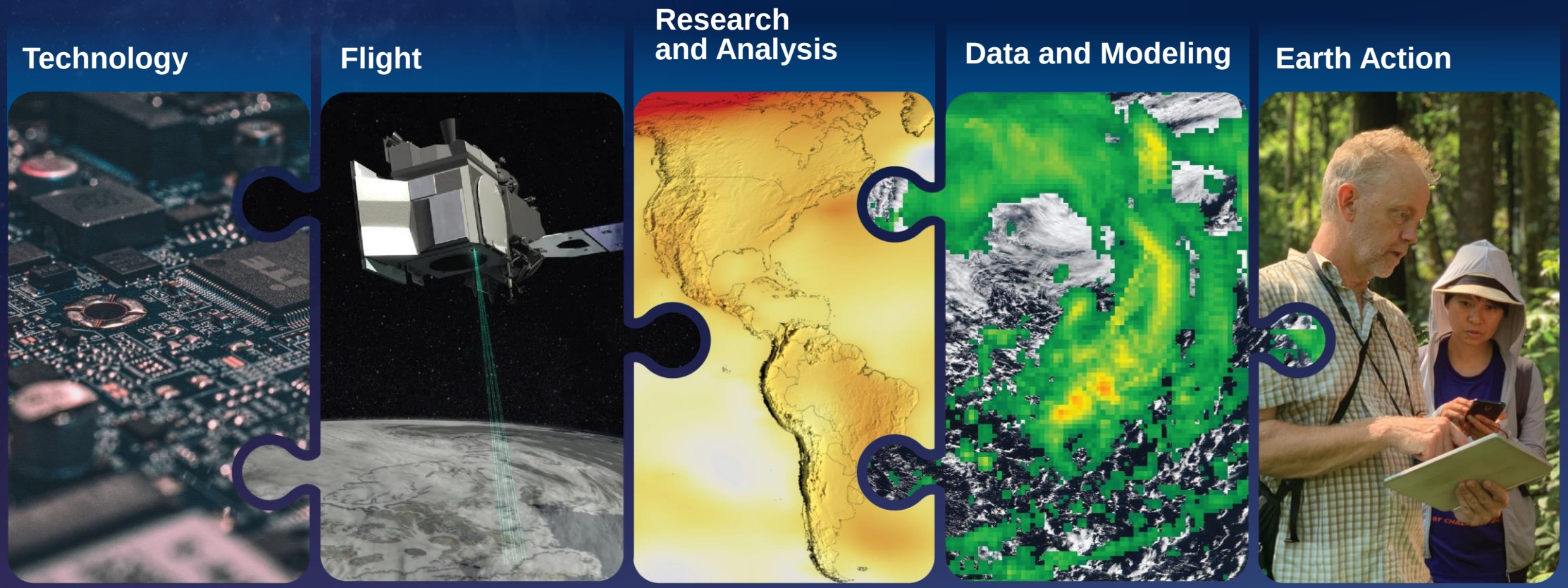


Key National Academies Guidance

- **Increase the impact of Earth science for the response to our changing planet**

- "Pursue increasingly ambitious objectives and innovative solutions that enhance and accelerate the science/applications value of space-based Earth observations and analysis to the nation and the world in a way that delivers great value, even when resources are constrained, and ensures that further investment will pay substantial dividends."
  - *- Thriving on Our Changing Planet: A Decadal Survey for Earth Observations from Space, 2017*

Advancing Earth System Science End-to-end



NASA earth

We are at a pivotal moment

The challenges we face are steep but we stand at the precipice of a golden age of Earth observation.

Earth Science to Action

What do we mean by “action”?

Our definition of action is accelerating the use of Earth science to support policy and decision-making for society’s well-being

- **Scale up:** Scale up existing efforts to get NASA science and data into hands of end users to solve real-world challenges
- **Build bridges:**
  - Build structural and cultural bridges between research, technology, flight, data, and Earth action elements
  - Identify and remove barriers to collaboration
- **Be user centered:** Prioritize info exchange with end users to allow their experiences to inform future programs

Are we cutting the research budget to do this?

No! The strategy does not call for defunding some efforts to start others. Work to implement this strategy will take place across all elements.

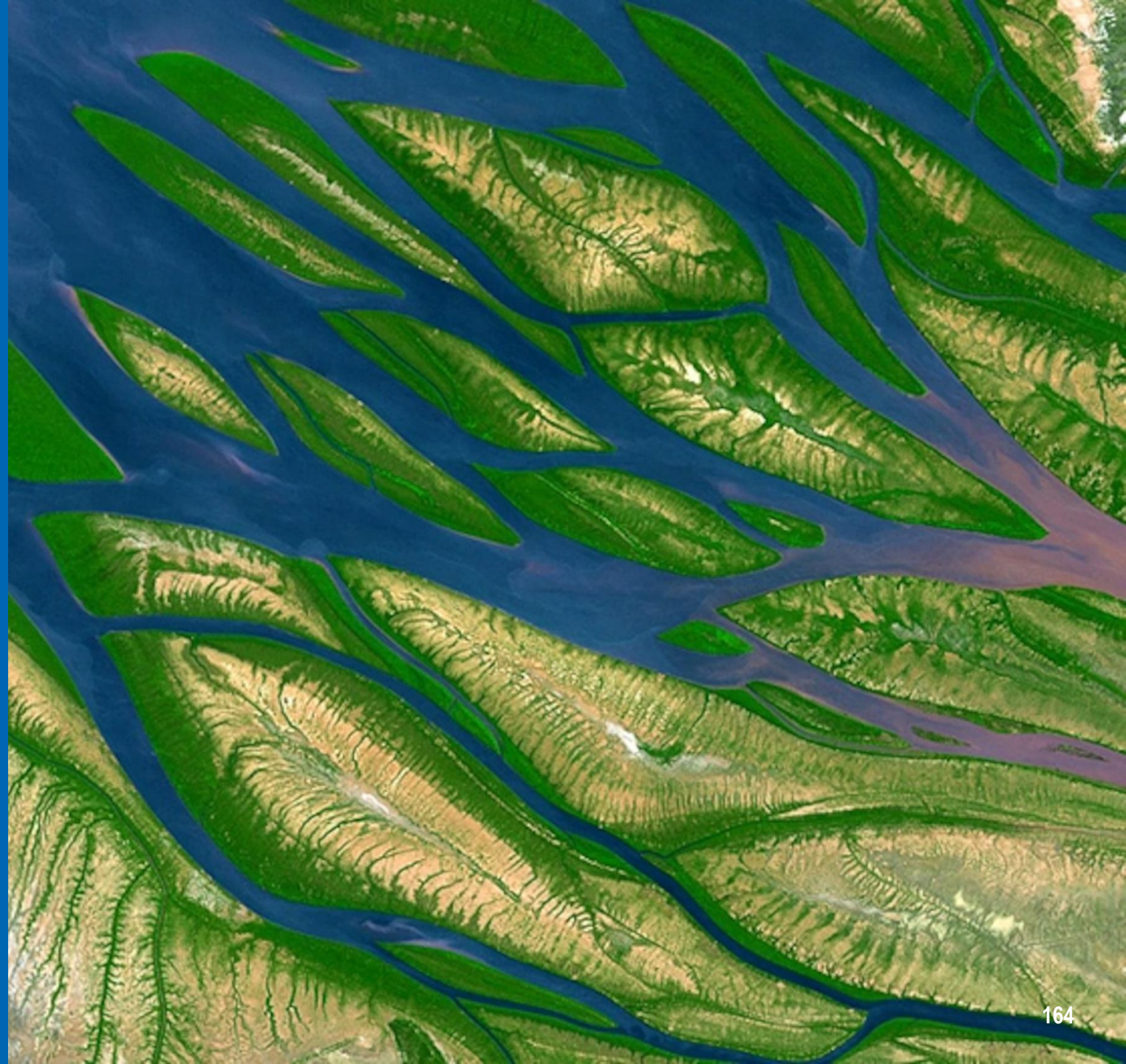
- R&A is a critical part of the strategy
- In some parts of ESD, implementation will be shared between R&A and Earth Action elements
- The overall goal is to realign responsibilities to enable deeper integration

OUR VISION

A thriving world, driven by trusted, actionable Earth science

OUR MISSION

Compelled by our planet’s rapid change, we innovate and collaborate to explore and understand the Earth system, make new discoveries, and enable solutions for the benefit of all



Aren’t we already doing this?

Our work has been excellent to date. Here are some examples to paint a picture of why change is still needed

A farmer managing crops

- Successfully used tools and techniques learned from previous generations to manage crops
- With increased frequency of drought and flooding, these tools, while previously effective, no longer suffice
- Makes changes and upgrades to remain successful under new conditions

Cascading effects

- Global warming is changing growing regions, impacting what grows where
- To address this new changing landscape, we must connect in ways we have not needed to before
- For example, moving from one mission at a time, to building integrated observatories that must work together

STRATEGIC GOAL

Within a decade, we will advance and integrate Earth science knowledge to empower humanity to create a more resilient world.

Objective 1

Holistically observe, monitor and understand the Earth system

Key Result 1.1: The most advanced Earth observing system in the world

Key Result 1.2: Cutting-edge technology

Key Result 1.3: Integrated and trusted Earth system data

Key Result 1.4: Scientific breakthroughs to better understand Earth

Objective 2

Deliver trusted information to drive Earth resilience activities

Key Result 2.1: Models that capture the intricacies of the Earth system

Key Result 2.2: Co-designed solutions and tools to support users

Key Result 2.3: Science-based information we can trust and act on

Key Result 2.4: Promotion of Earth information as a national asset

Guiding Principles

1. Amplify impact and augment our capabilities through enhanced partnerships
2. Engage a diverse workforce and the wider Earth science community
3. Use a balanced approach when faced with competing factors
4. Encourage innovation to maintain cutting edge capabilities
5. Ensure robustness and resilience in our programs

Visualizing the strategy at work

Earth Science to Action Strategy

Virtuous Cycle
- User needs inform next iteration of programs, missions and initiatives

Public Understanding & Exchange
- Put more scientific understanding into public sphere
- Deliver applied science to users
- Participate in multi-way info exchange
- Use input to inform subsequent work

Solutions & Societal Value
- Offer models, scientific findings and info through Open-Source Science principles
- Support climate services
- Provide science applications and tools to inform decisions

Earth System Science & Applied Research
- Grow scientific understanding of Earth's systems
- Develop predictive modeling for science applications and tools to mitigate, adapt and respond to climate change

Foundational Knowledge, Technology, Missions & Data
- Technology innovation
- Earth observations missions
- Data collected from space, air and ground

NASA earth

02.13.2024

Example: NASA-USGS GEMx Campaign

Virtuous Cycle
- User needs inform development of campaign planning

Public Understanding & Exchange
- GEMx open data portal; USGS high-level products
- Initiated NASA airborne Tribal engagement efforts

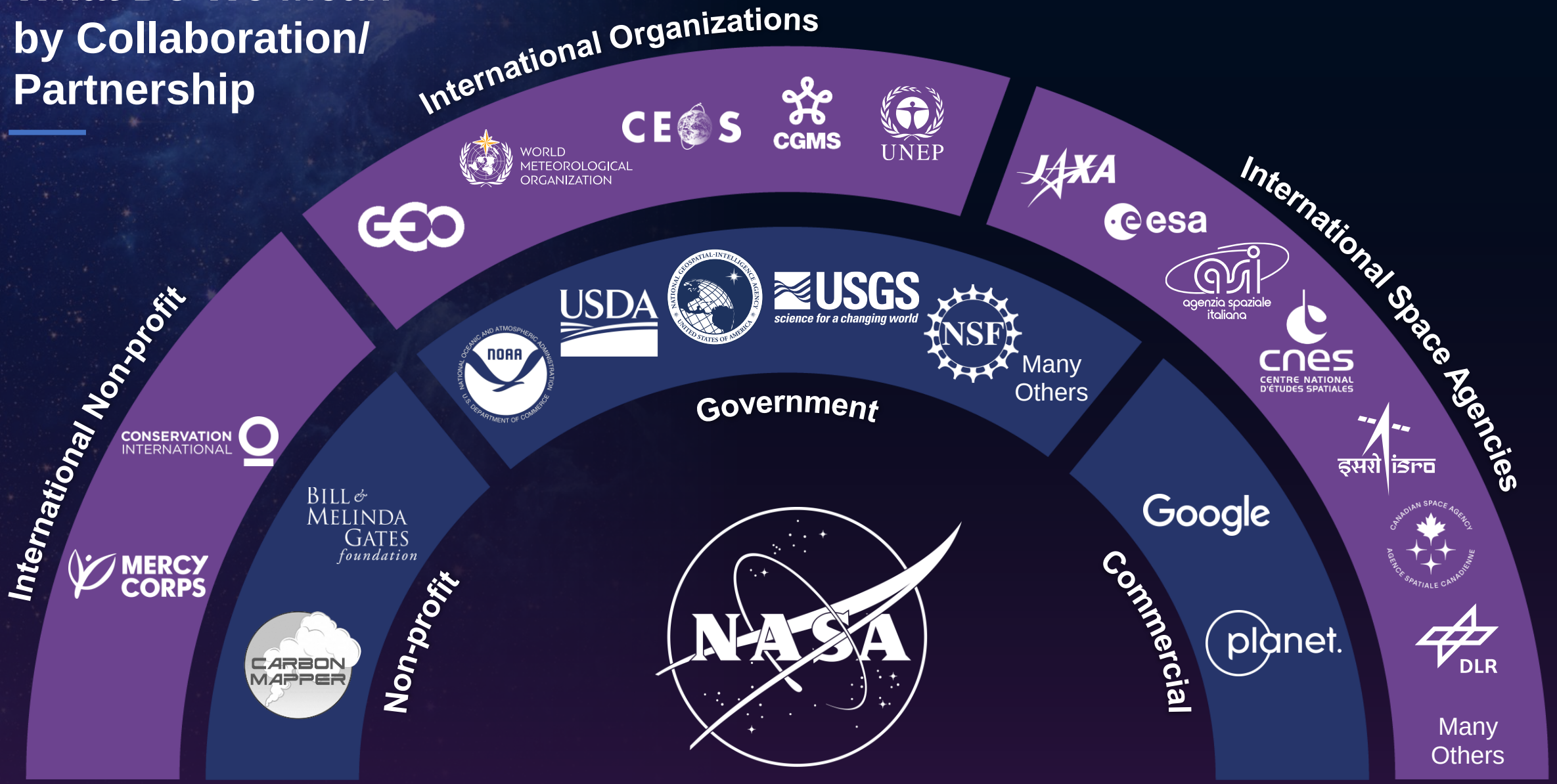
Solutions & Societal Value
- Contribution to the Clean Energy Act of 2020 and climate change mitigation
- Improves domestic supply for components of critical technologies

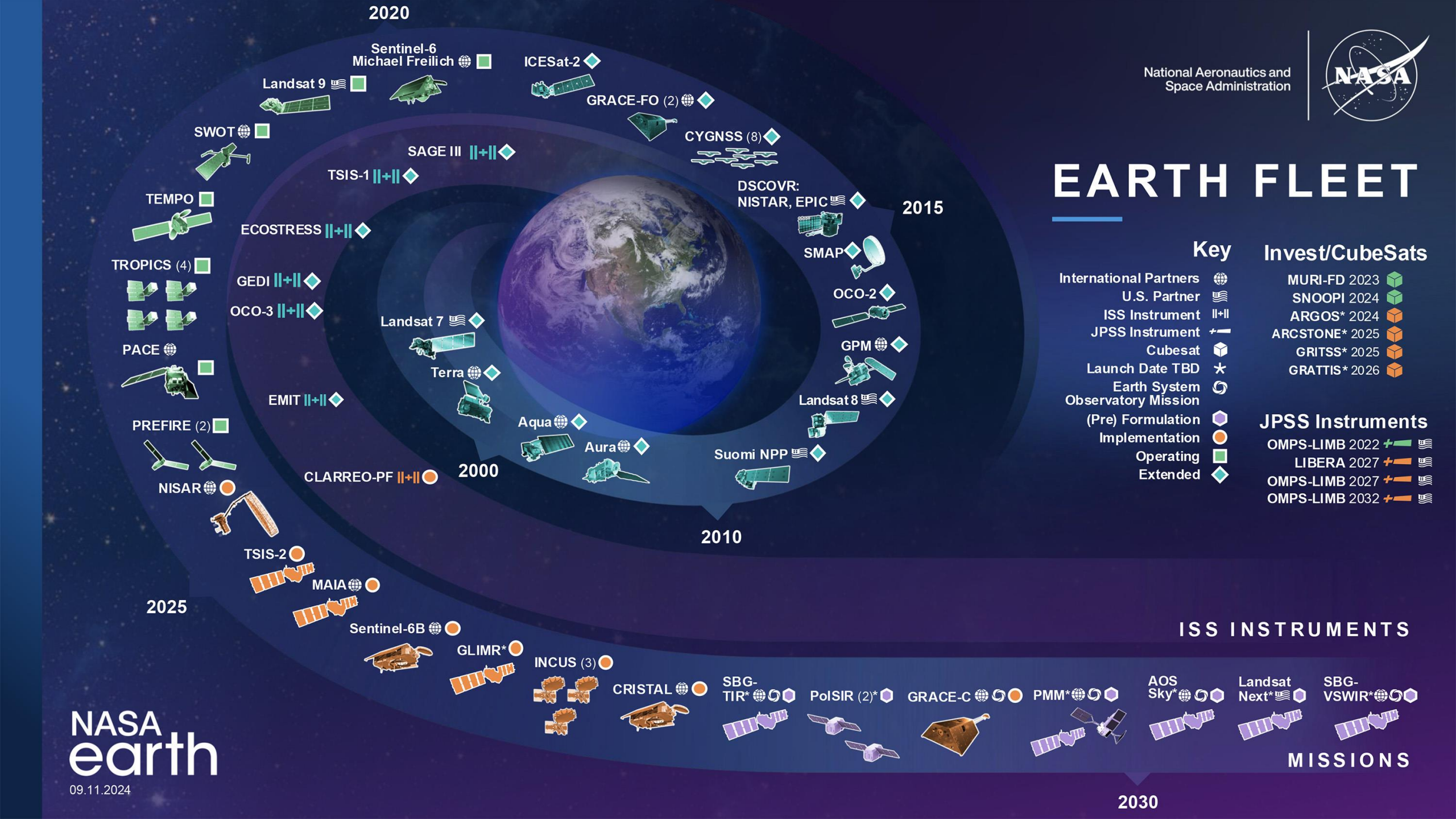
Earth System Science & Applied Research
- Critical Mineral exploration, using spectral analysis to identify the location of and types of minerals

Foundational Knowledge, Technology, Missions & Data
- Mineral mapping and identification at 15 m2 over SW US
- VSWIR/TIR data from NASA spectrometers and imagers flown on the ER-2

NASA earth

What Do We Mean by Collaboration/ Partnership





National Aeronautics and Space Administration

EARTH FLEET

Key

- International Partners
- U.S. Partner
- ISS Instrument
- JPSS Instrument
- Cubesat
- Launch Date TBD
- Earth System Observatory Mission
- (Pre) Formulation
- Implementation
- Operating
- Extended

Invest/CubeSats

- MURI-FD 2023
- SNOOPI 2024
- ARGOS* 2024
- ARCSTONE* 2025
- GRITSS* 2025
- GRATTIS* 2026

JPSS Instruments

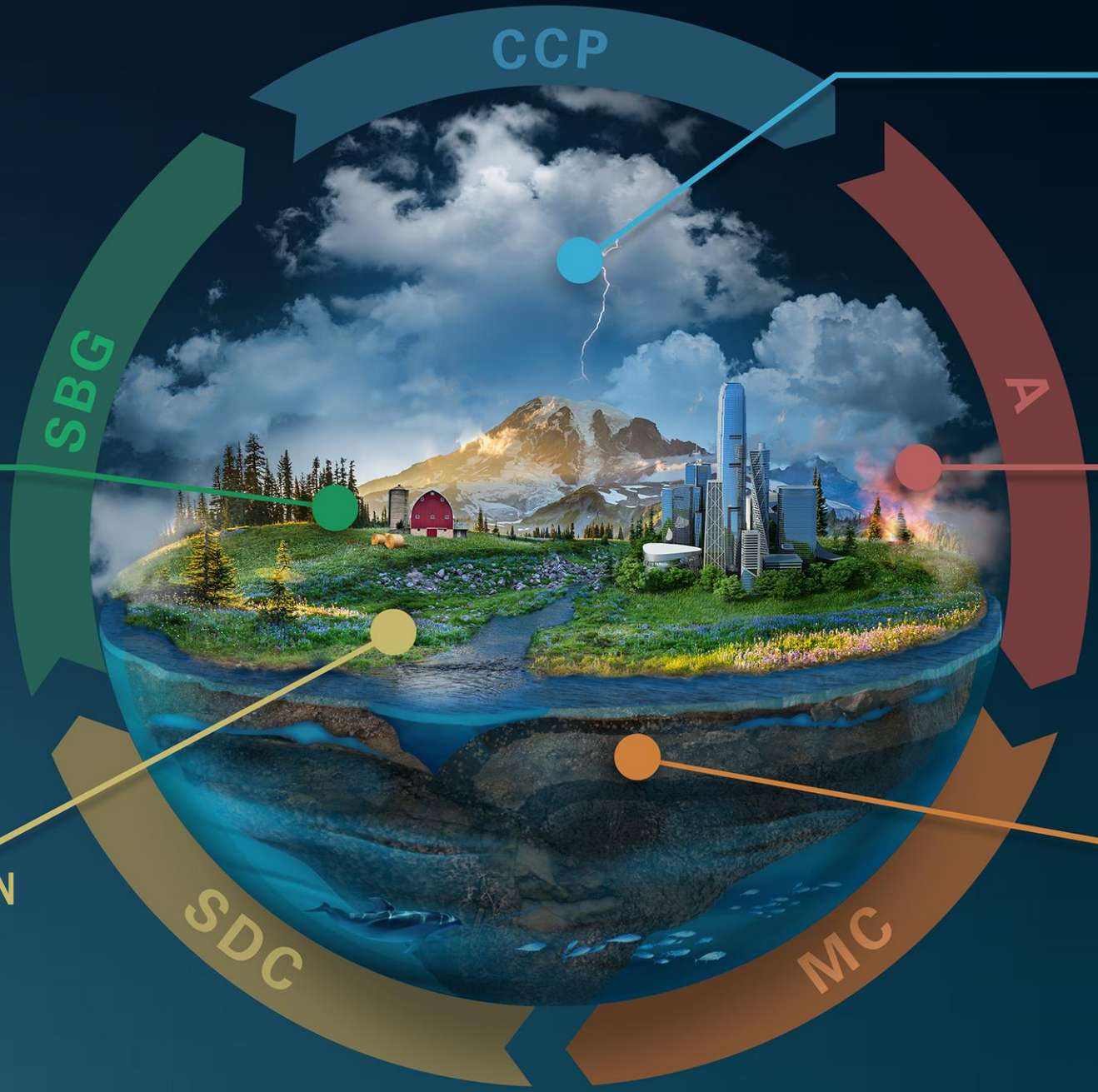
- OMPS-LIMB 2022
- LIBERA 2027
- OMPS-LIMB 2027
- OMPS-LIMB 2032

NASA earth

09.11.2024

EARTH SYSTEM OBSERVATORY

INTERCONNECTED CORE MISSIONS



CLOUDS, CONVECTION AND PRECIPITATION

Water and Energy in the Atmosphere

AEROSOLS

Particles in the Atmosphere

MASS CHANGE

Large-scale Mass Redistribution

SURFACE DEFORMATION AND CHANGE

Earth Surface Dynamics

SURFACE BIOLOGY AND GEOLOGY

Earth Surface & Ecosystems

Urgency

Responsibility

Ownership

URL for NASA Earth Science to Action website


NASA
NASA
earth
science.nasa.gov/earth
Your Home. Our Mission.

BREAK

Committee will reconvene at 2:40pm ET

National Aeronautics and Space Administration

Discussion Panel: Space Weather Hazard Mitigation and SMD Roles

Joe Westlake, Heliophysics Division Director, NASA SMD

Jamie Favors, HPD Space Weather Program Director, NASA SMD

National Aeronautics and Space Administration

Space Weather Hazard Mitigation and SMD Roles

NAC Science Committee
October 2024

Dr. Joseph Westlake
Director, NASA Heliophysics Division

Jamie Favors
Director, NASA Space Weather Program

Space Weather Hazard Mitigation and SMD Roles

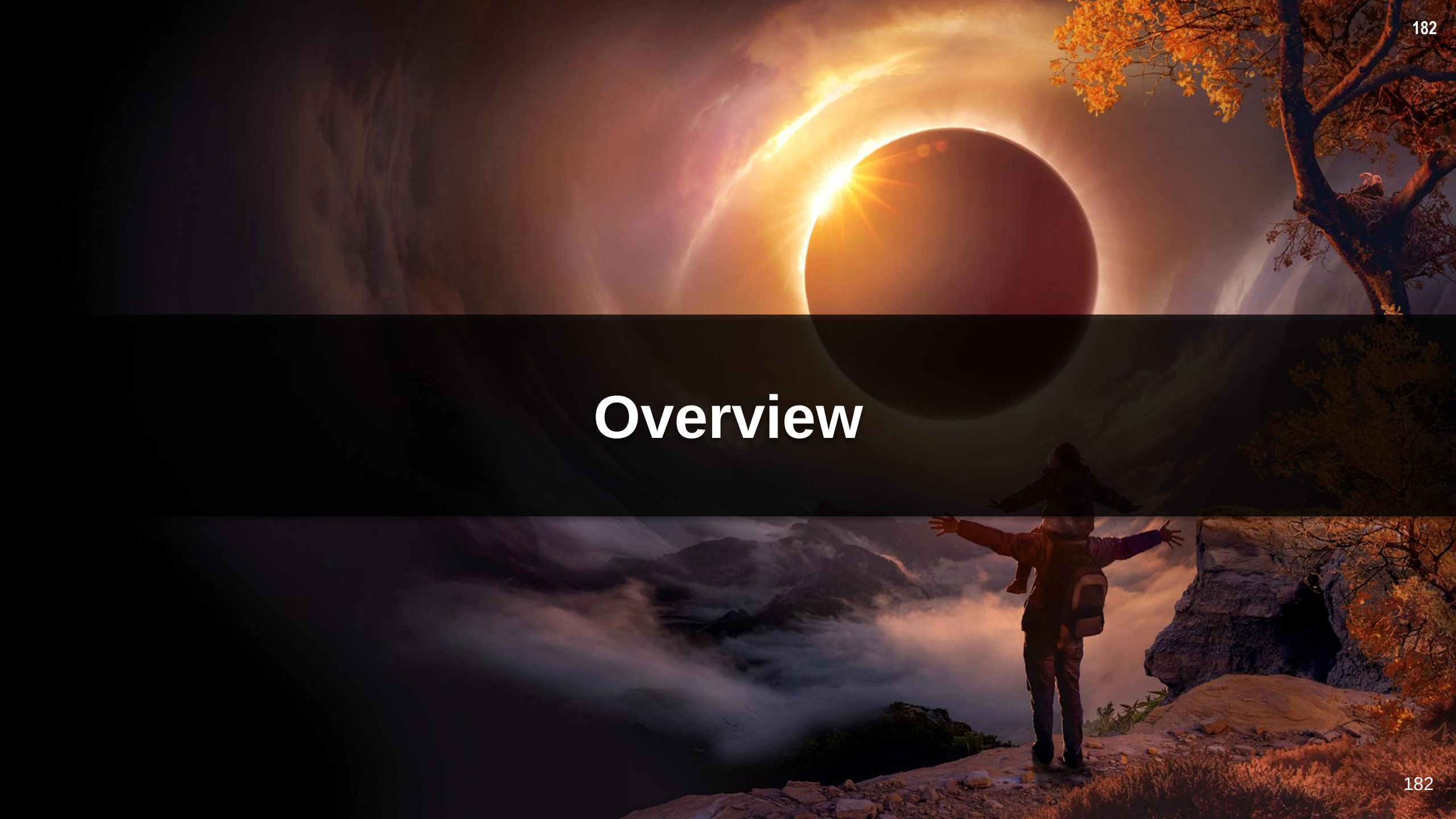
NAC Science Council written request: "The SC would like an update on detection and warning capabilities for space weather events"

Speakers:

- **Joe Westlake**, Director of the NASA Heliophysics Division
- **Jamie Favors**, Director of the NASA Space Weather Program

Agenda:

- Stage Setting, Top-Level, Policy, Interagency (Joe)
- Overview of the NASA Space Weather Program (Jamie)
- Space Weather Tabletop Exercise (Jamie)
- May 2024 Storm; Earth & Mars (Jamie)
- Q&A (Joe & Jamie)



Overview

National Space Weather Program

The NSWP is an interagency initiative to speed improvement in space weather services and prepare the Nation to deal with technological vulnerabilities associated with the space environment.

NSWP Agency Participants

NOAA Space Weather Prediction Center

U.S. government's official source for space weather forecasts, alerts, and watches/warnings

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NASA Space Weather Program

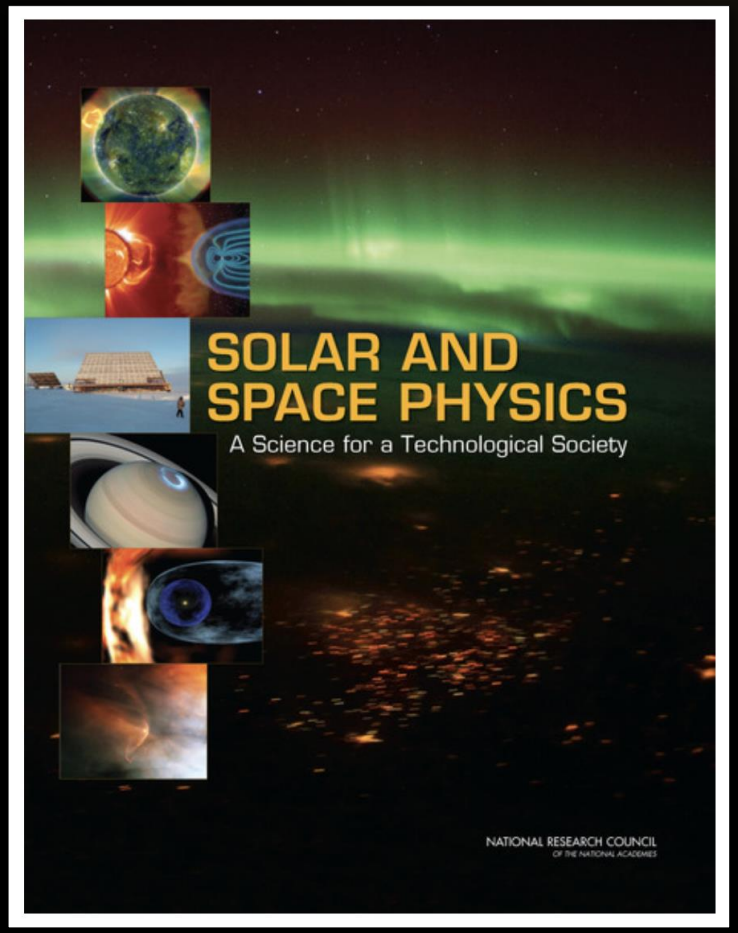
Research and applications arm of the Nation's space weather effort that supports improvements in space weather forecasting and services

Implements Research-to-Operations-to-Research on behalf of, and in collaboration with, NOAA, DoD, and NSF to accelerate targeted space weather applied research and applications toward operational use

Develops space weather missions to advance space weather understanding and forecasting across the solar system

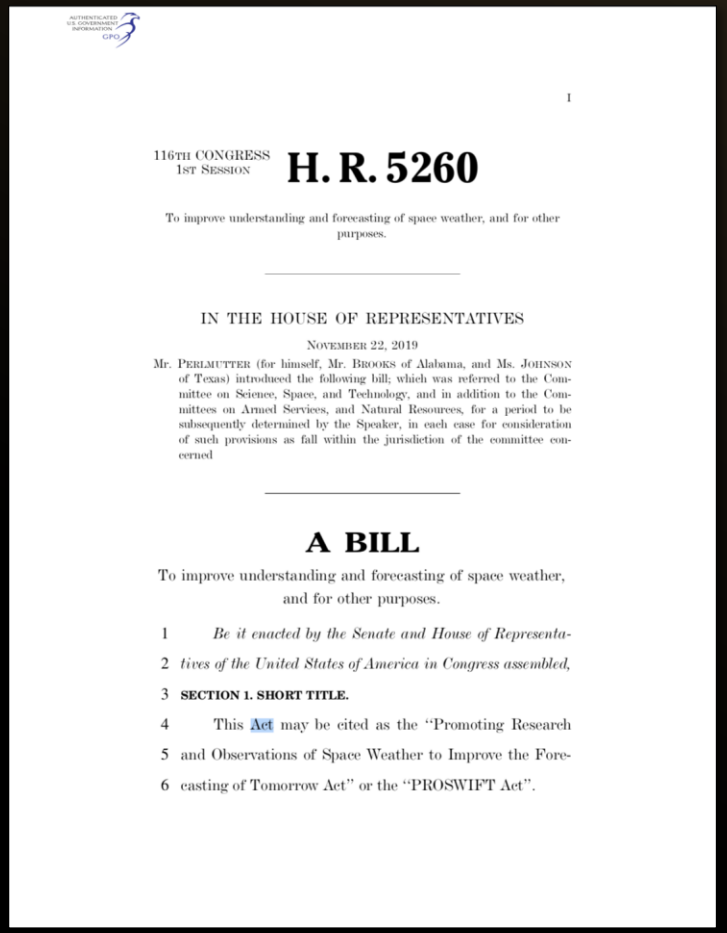
Supports NASA human exploration missions in collaboration with NOAA SWPC and NASA exploration planning with the Moon to Mars Program

US Space Weather Policy & Guiding Documents



Decadal 2013-2022

New Decadal expected in Nov 2024



116TH CONGRESS
1ST SESSION

H. R. 5260

To improve understanding and forecasting of space weather, and for other purposes.

IN THE HOUSE OF REPRESENTATIVES

NOVEMBER 22, 2019

Mr. PERLMUTTER (for himself, Mr. BROOKS of Alabama, and Ms. JOHNSON of Texas) introduced the following bill; which was referred to the Committee on Science, Space, and Technology, and in addition to the Committees on Armed Services, and Natural Resources, for a period to be subsequently determined by the Speaker, in each case for consideration of such provisions as fall within the jurisdiction of the committee concerned

A BILL

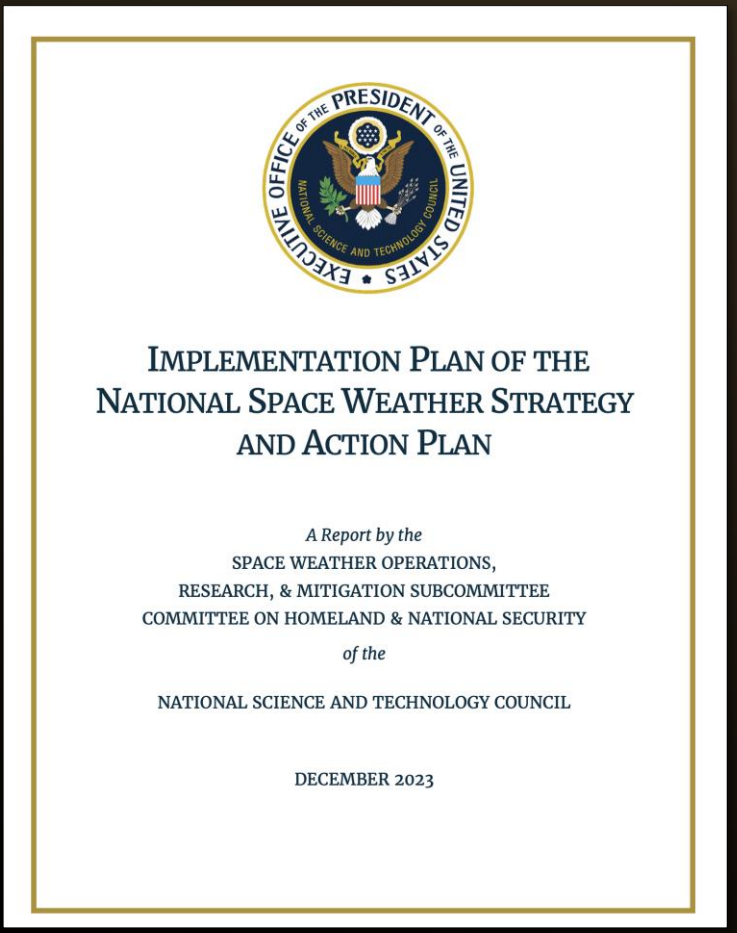
To improve understanding and forecasting of space weather, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Promoting Research and Observations of Space Weather to Improve the Forecasting of Tomorrow Act" or the "PROSWIFT Act".

PROSWIFT Act 2020



EXECUTIVE OFFICE OF THE PRESIDENT OF THE UNITED STATES
NATIONAL SCIENCE AND TECHNOLOGY COUNCIL

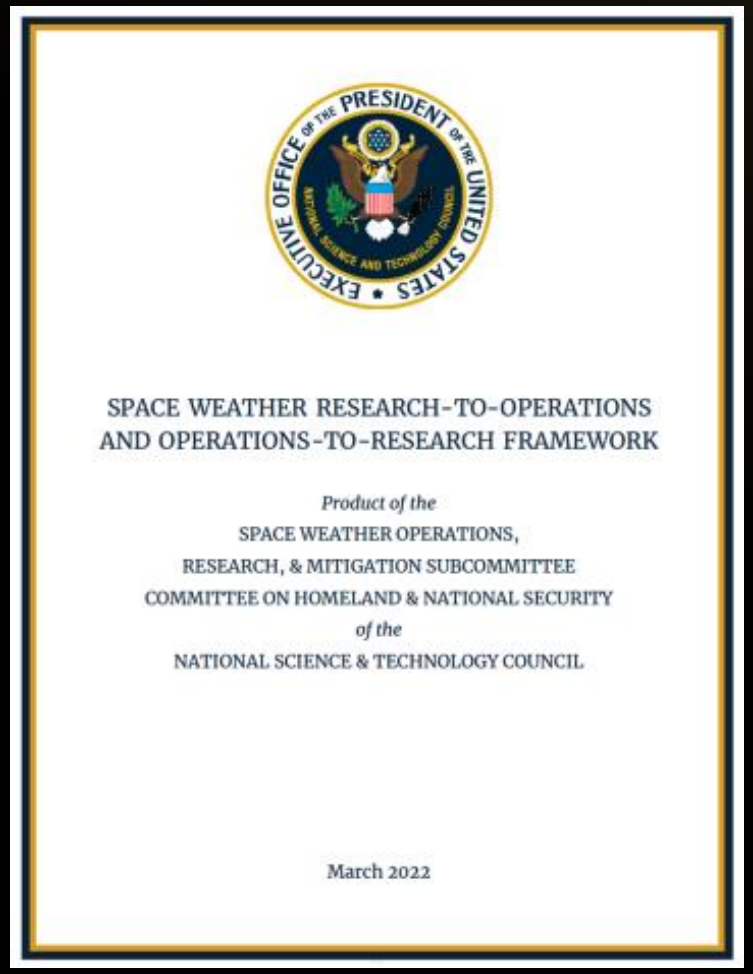
IMPLEMENTATION PLAN OF THE NATIONAL SPACE WEATHER STRATEGY AND ACTION PLAN

A Report by the
SPACE WEATHER OPERATIONS,
RESEARCH, & MITIGATION SUBCOMMITTEE
COMMITTEE ON HOMELAND & NATIONAL SECURITY
of the
NATIONAL SCIENCE AND TECHNOLOGY COUNCIL

DECEMBER 2023

National Space Weather Strategy and Action Plan & Implementation Plan

US Space Weather Policy & Guiding Documents



SPACE WEATHER RESEARCH-TO-OPERATIONS
AND OPERATIONS-TO-RESEARCH FRAMEWORK

Product of the
SPACE WEATHER OPERATIONS,
RESEARCH, & MITIGATION SUBCOMMITTEE
COMMITTEE ON HOMELAND & NATIONAL SECURITY
of the
NATIONAL SCIENCE & TECHNOLOGY COUNCIL

March 2022

Framework fosters the interagency collaborative transition of new and/or updated space weather capabilities into operations.

NASA has just concluded a year-long effort to assess the Space Weather R2O2R process and pull lessons from similar science applications groups (e.g., NASA Earth Action / Applied Sciences).

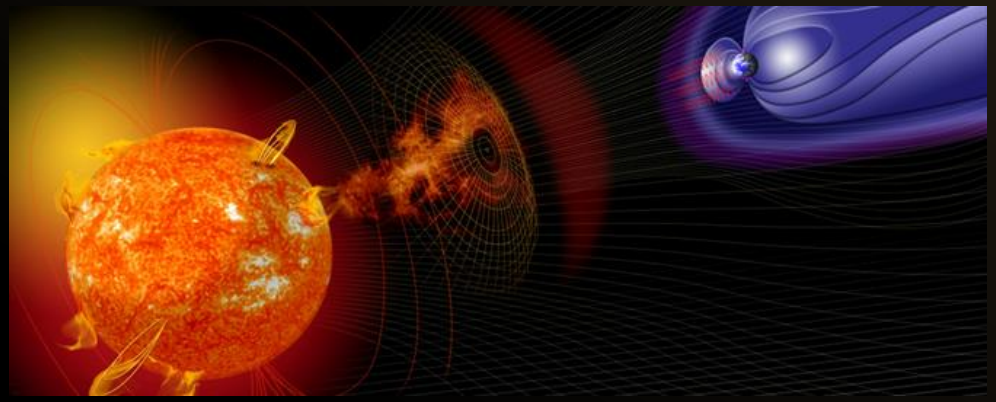
In addition, NASA has recently rolled out an **updated approach that will begin in February 2025**.

Space Weather Operations, Research, and Mitigation (SWORM)

The Space Weather Operations, Research, and Mitigation (SWORM) Subcommittee is a Federal coordinating body organized under the National Science and Technology Council (NSTC) Committee on Homeland and National Security, organized under the Office of Science and Technology Policy (OSTP).

SWORM coordinates Federal Government department and agency activities to meet the goals and objectives specified in the National Space Weather Strategy and Action Plan (NSW-SAP) released in March 2019.

The Space Weather Advisory Group (SWAG) advises the SWORM based on advice from academia, the commercial space weather sector, and space weather end users.

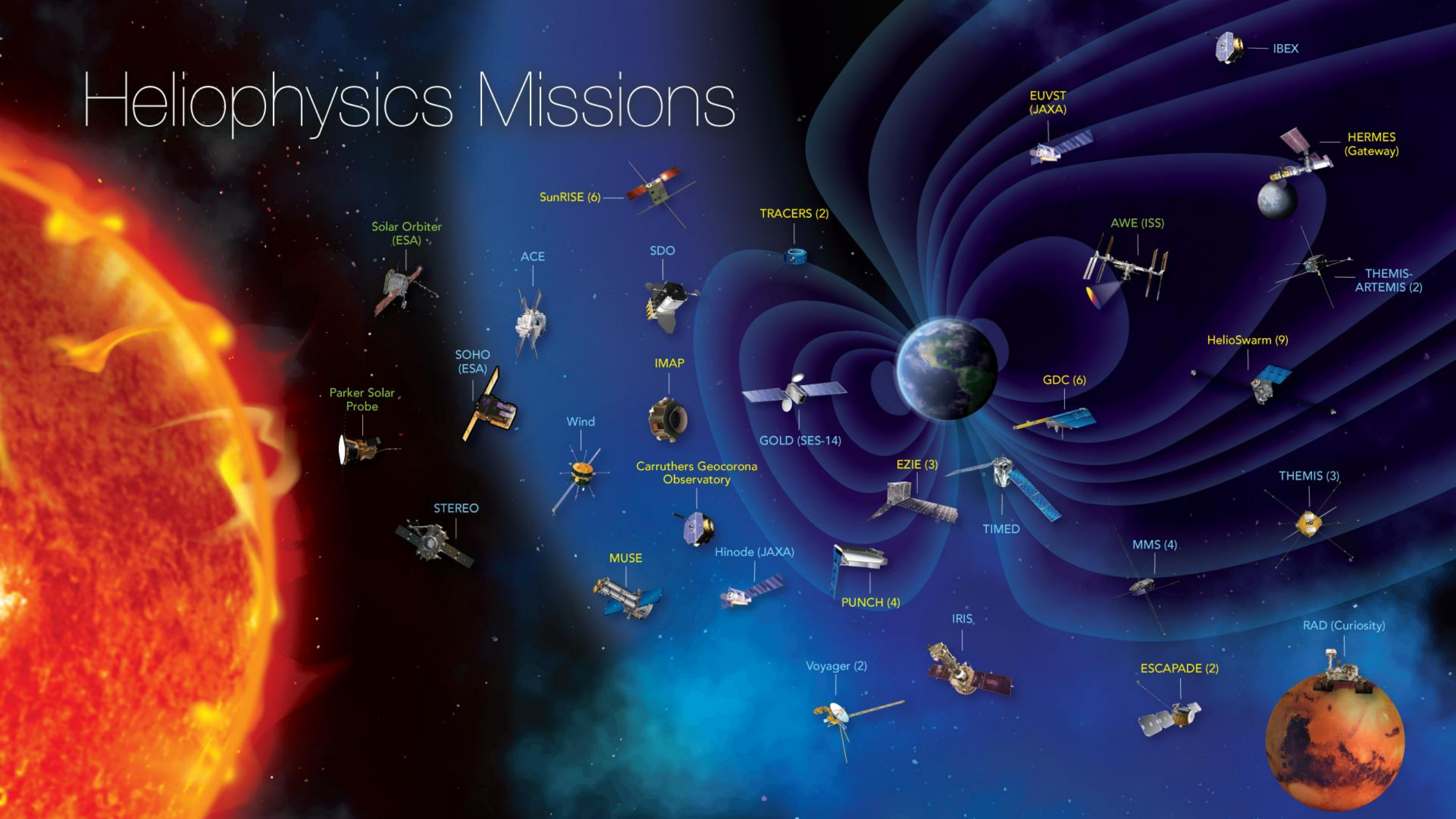


NASA Heliophysics Space Weather Council (SWC)

NASA's Heliophysics Division established the SWC in 2020 to secure the counsel of community experts across diverse areas of matters relevant to space weather in support the NASA Heliophysics Division. The SWC is a subcommittee to the NASA Advisory Council's Heliophysics Advisory Committee (HPAC).

The SWC serves as a community-based, interdisciplinary forum for soliciting and coordinating community analysis and input to provide advice on space weather topics to the Heliophysics Division Director through HPAC.

Heliophysics Missions



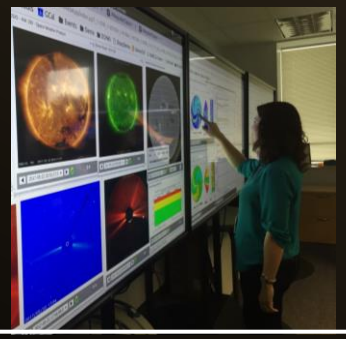
NASA Space Weather Program

NASA Space Weather Program

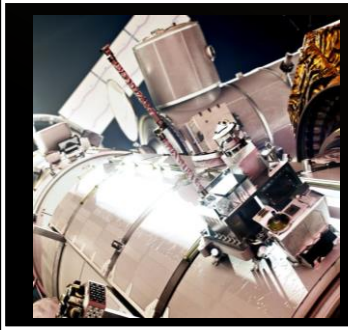
NASA plays a vital role in space weather by **addressing fundamental science, applied research, and applications** and is a **critical partner for the Nation's operational forecasting** performed by NOAA and the Department of Air Force.

User-driven applied research and applications for forecasting and decision making (e.g., R2O2R)

Provide platforms for community modeling and intercomparison & validation efforts

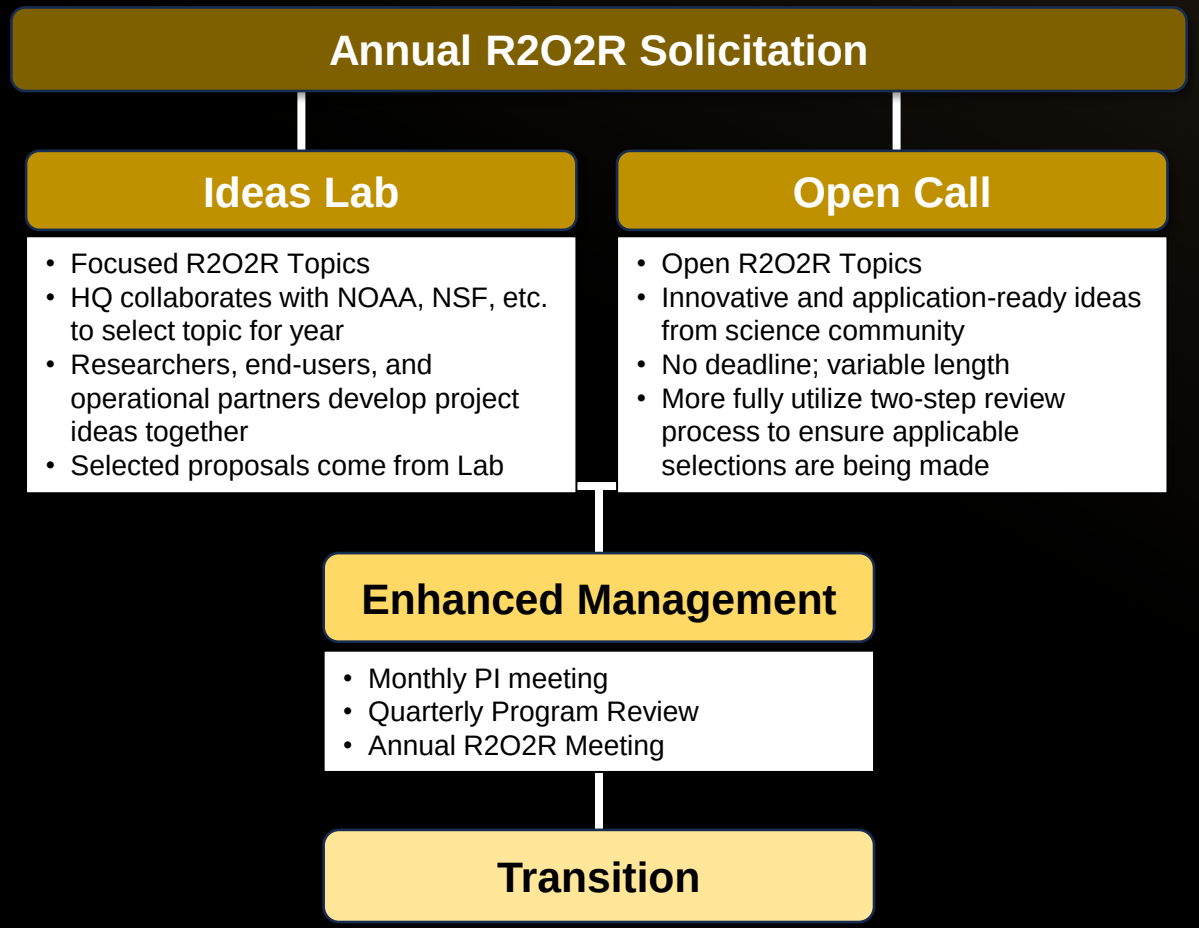


Support human & robotic exploration through applied research, environmental analysis, and measurements



User-driven measurements, missions, and technology development (e.g., HERMES)

NASA Space Weather Program
R2O2R Program Element – New Approach



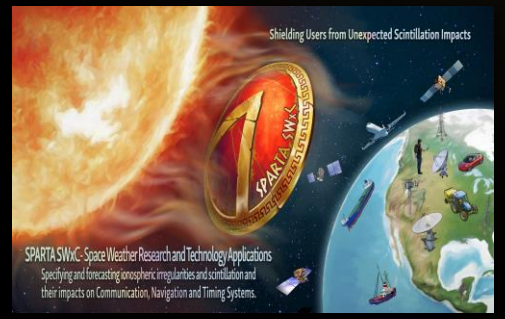
New approach **continues to meet NASA's responsibilities** as defined in PROSWIFT Act, National Space Weather Strategy & Action Plan, etc.

New approach **addresses issues & actions** identified by NASA, NOAA, NSF, DoD, and the science community. **Truly interagency approach**.

New **approach leverages successful pilot efforts and lessons learned** from similar programmatic activities (i.e., UK SWIMMR and NASA Applied Sciences)

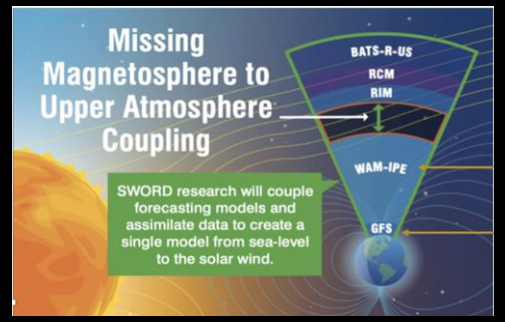
NASA Lead: Dr. Lisa Winter-Baek, Program Scientist (on detail from NSF)
NASA Deputy Lead: Dr. Esayas Shume, Program Scientist

NASA Space Weather Centers of Excellence



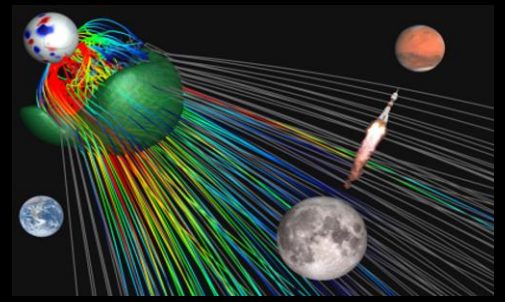
Space Weather Research and Technology Applications (SPARTA) Center of Excellence

- *PI: Keith Groves, Boston College*



Space Weather Operational Readiness Development (SWORD) Center

- *PI: Thomas Berger, University of Colorado, Boulder*



CLEAR: Center for All-Clear SEP Forecast

- *PI: Lulu Zhao, University of Michigan, Ann Arbor*

Joint Selection w/ Department of Commerce:

Center of Excellence for Advanced Forecasting of Drag for Enhanced, Sustainable, and Conscientious Space Operations

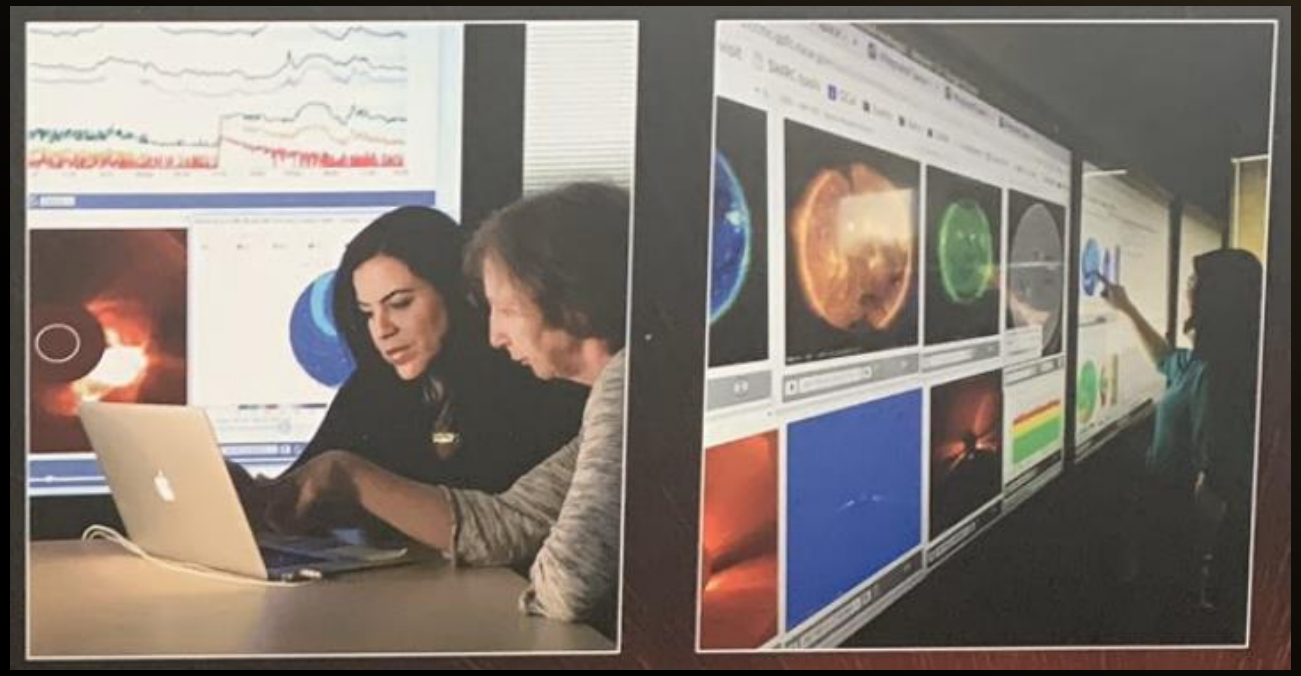
- *PI: Piyush Mehta, West Virginia University, Morgantown*

Moon to Mars Space Weather Analysis Office

Mission Statement: The Moon to Mars (M2M) Space Weather Analysis Office was established to support NASA's Space Radiation Analysis Group (SRAG) with human space exploration activities by providing novel capabilities to characterize the space radiation environment. M2M also supports NASA robotic missions with space weather assessments and anomaly analysis support.

NASA Robotic Mission Partners

M2M serves as a proving grounds and testbed for the capabilities that will eventually transition to operational forecasting agencies.



Current Limitations and Challenges for Space Weather Prediction

Current Limitations & Challenges for Prediction

Note: This is my list and not from an operational forecasting center

Science Examples

- Physical understanding of these processes
- Pre-event (e.g., solar flare) signatures
- Model advancements (e.g., data assimilation)
- Understanding of impacts on Earth system and infrastructure

Measurements Examples

- Limited real-time / near real-time observations
- Ahead / ”Upstream” of Sun-Earth L1
- Limited ground measurements (e.g., magnetometers)
- Very limited upper atmosphere (i.e., Ionosphere-Thermosphere)
- Off Sun-Earth Line (e.g., L5, L4, Mars L1, solar farside) ***> Example later in this discussion***

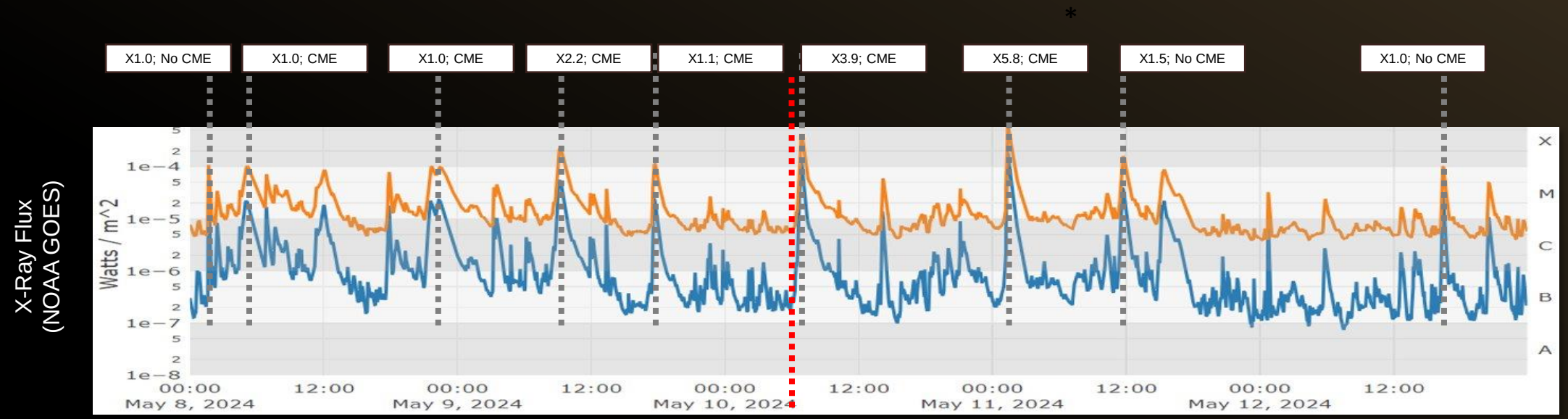
NASA M2M Space Weather Analysis Office during the May 2024 solar storm

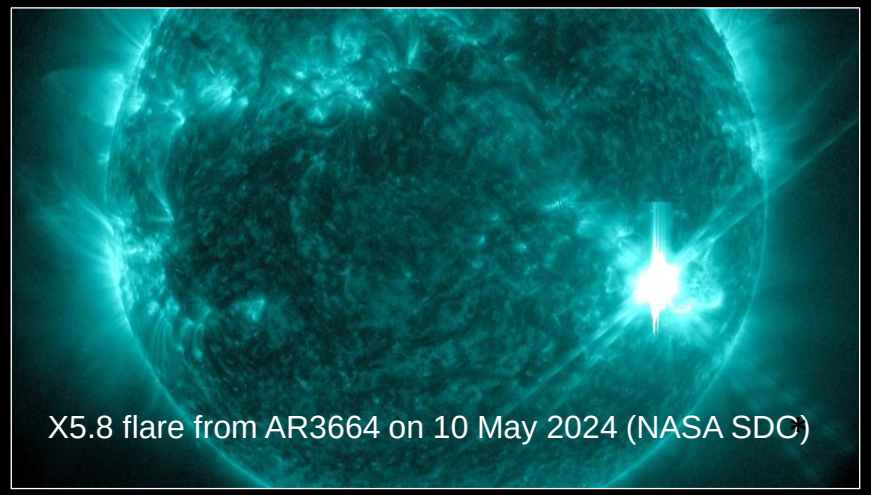
Space Weather Tabletop Exercise and May 2024 Solar Storm

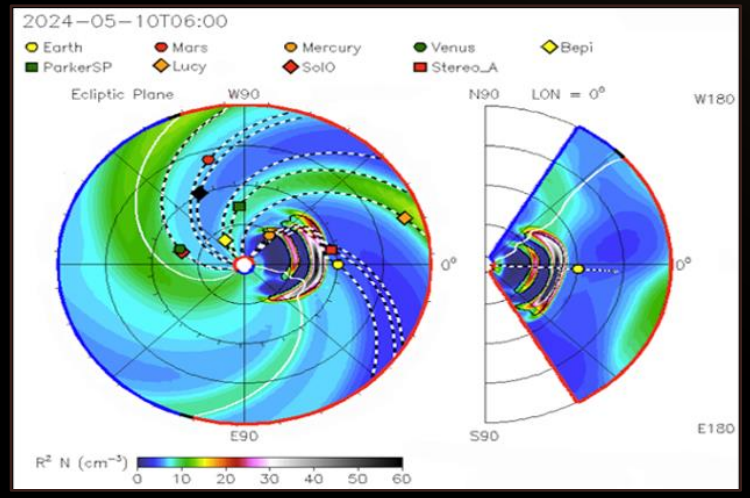
2024 Space Weather Tabletop Exercise

- On 8-9 May 2024, the first ever end-to-end Space Weather Tabletop Exercise was held (two concurrent locations: APL in Laurel, MD, and FEMA Region 8 in Denver, CO)
- Participants included NASA, NOAA SWPC and Space Weather Observations, NSF, FEMA, WH / OSTP, DoD Dept. of Air Force, etc.
- Exercise to provide a low-stress, no-fault environment for generating dialogue about the challenges of preparing for and responding to an impending space weather event

May 2024 Solar Storm: Source







- Nine X-class flares with 14 Earth-directed CMEs
- "*No one CME was 'spectacular' on their own*"
- Numerical models struggled with simulations that contained numerous CMEs

Source: NASA M2M, Sep. 2024

May 2024 Solar Storm: Reported Impacts

Energy Sector

- US and Canada grid operators took numerous actions to mitigate impacts
- High voltage lines tripped in northern Europe
- UK transformers overheated/alarmed
- New Zealand disconnected northern islands power

Satellite Operations

- ~5000 Satellites experienced increased drag, necessitating more frequent station-keeping burns and collision avoidance maneuvers
- Degraded Starlink service
- Global communications satellite lost sync lock

Aviation

- Trans-oceanic flights rerouted due to High Frequency radio loss
- Wide Area Augmentation System used for precision landing and performance- based navigation unavailable for ~15 hours
- Notice to Air Mission advising of comms/nav. disruptions

GPS Systems

- Loss of lock on GPS signals
- Range errors
- Both civilian and defense
- Idled Midwest planting

BUSINESS INSIDER

John Deere dealership says a solar storm left GPS tracking on farmers' tractors 'extremely compromised'

Ana Altchek May 13, 2024, 3:08 PM MDT Share Save

Source: NOAA SWPC, July 2024

May 2024 Solar Storm: Forecast & Lessons

A Decade of Preparedness Paid Off, but Challenges Remain

Significant Events		NOAA Forecast	Actual Observed
March 2023	✗	G2	G4
April 2023	✗	G2	G4
March 2024	✗	G3	G4
May 10-11 2024	✓	G4-G5	G5
May 12 2024	✗	G4-G5	G3
June 2024	✗	G1	G4

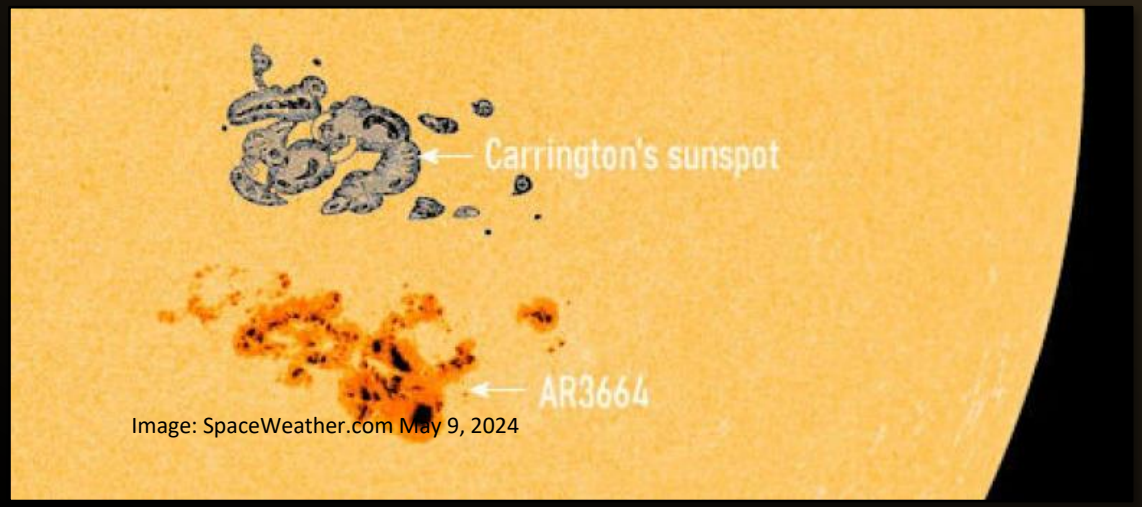


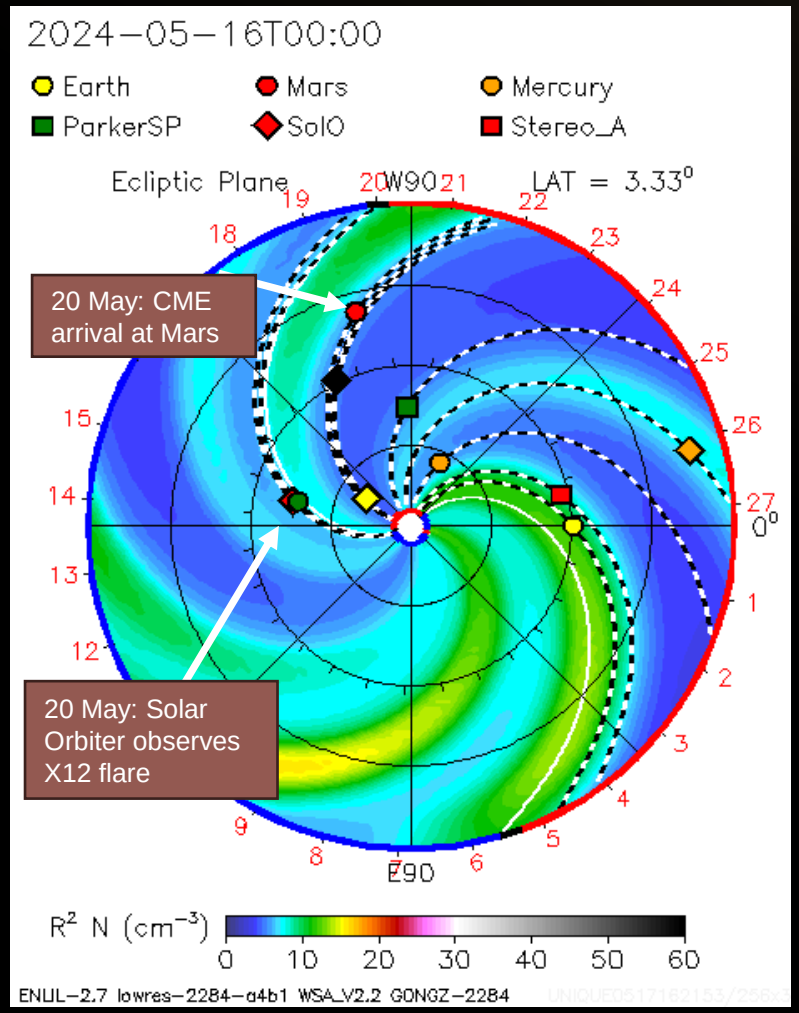
Image: SpaceWeather.com May 9, 2024

Insufficient science and operational capabilities to accurately predict geomagnetic storm intensity

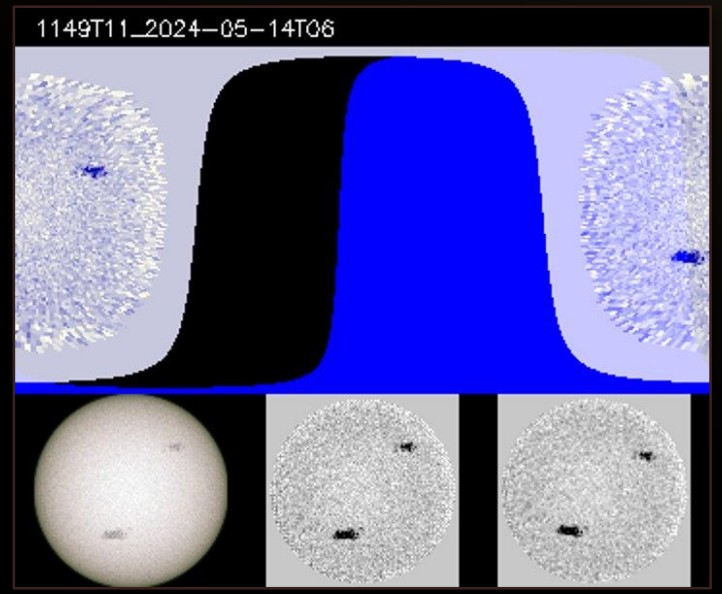
A G5 storm but not a Carrington-Class event: Highlights need to transform Space Weather Scales and Products

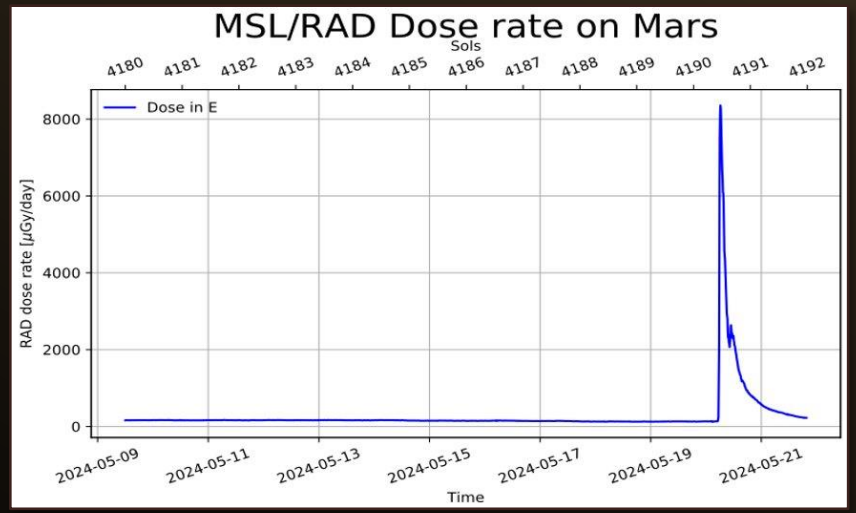
Source: NOAA SWPC, July 2024

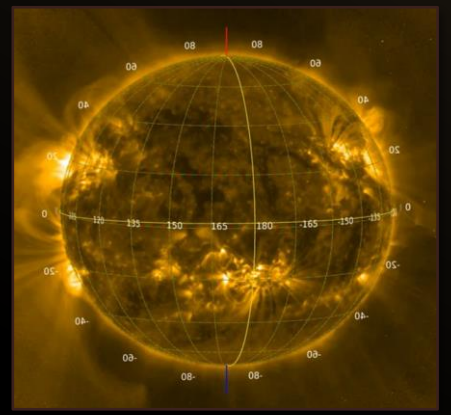
May 2024 Solar Storm: Mars

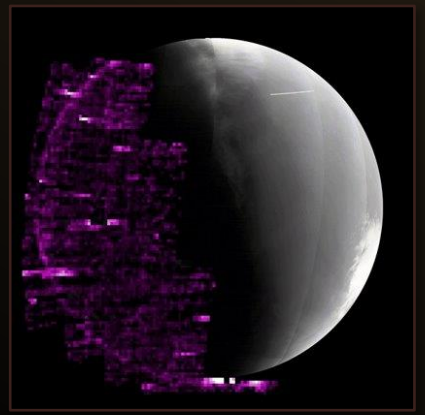


- AR3446 continued to be very active (e.g., estimated X12 flare)
- Largest energetic particle event measured at Mars
- Case study of importance to human exploration and need for off Sun-Earth Line measurements









Source: NASA M2M, Sep. 2024

Thank You!

BREAK

Committee will reconvene at 4pm ET

Committee Discussion

Meeting Adjourned

Committee will reconvene at 10:15am ET on October 10, 2024

NAC SCIENCE COMMITTEE FALL MEETING

October 8-10, 2024

Designated Federal Officer (DFO) Introduction

Nathan Boll

Executive Secretary

Overview of Agenda

TUESDAY:
NAC Meeting Reports (May, October)
NASA Science Mission Directorate Update
Panel Discussion: NASA IDEA Initiatives and SMD Updates
Panel Discussion: SMD Open Science Initiatives Update
Committee Discussion (90 min)
[note that we do not have public comment/Q&A on agenda until Thurs (10 min)]

WEDNESDAY:
DAC Chair reports
Panel Discussion: Climate Change and Earth System Science Strategy
Panel Discussion: Space Weather Hazard Mitigation and SMD Roles
Committee Discussion (90 min)

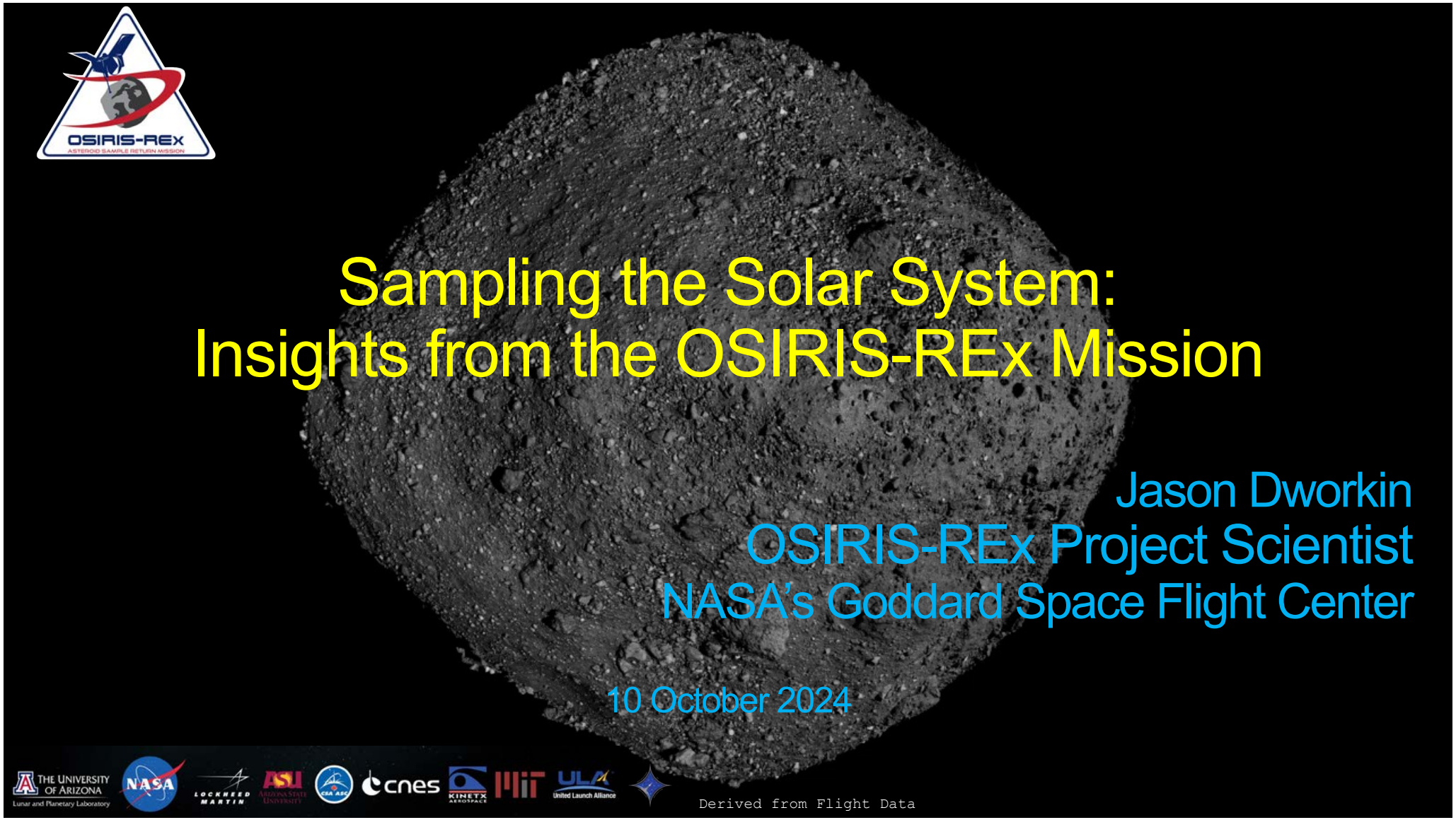
THURSDAY:
Public Lecture: OSIRIS-REx
Public Comment Period
Outbrief to NASA SMD

National Aeronautics and Space Administration

Public Lecture: Science Discoveries from the OSIRIS-REx Mission

Jason Dworkin, OSIRIS-REx Project Scientist
Goddard Space Flight Center

With introduction by:
David Smith, OSIRIS-REx Program Scientist
NASA Headquarters

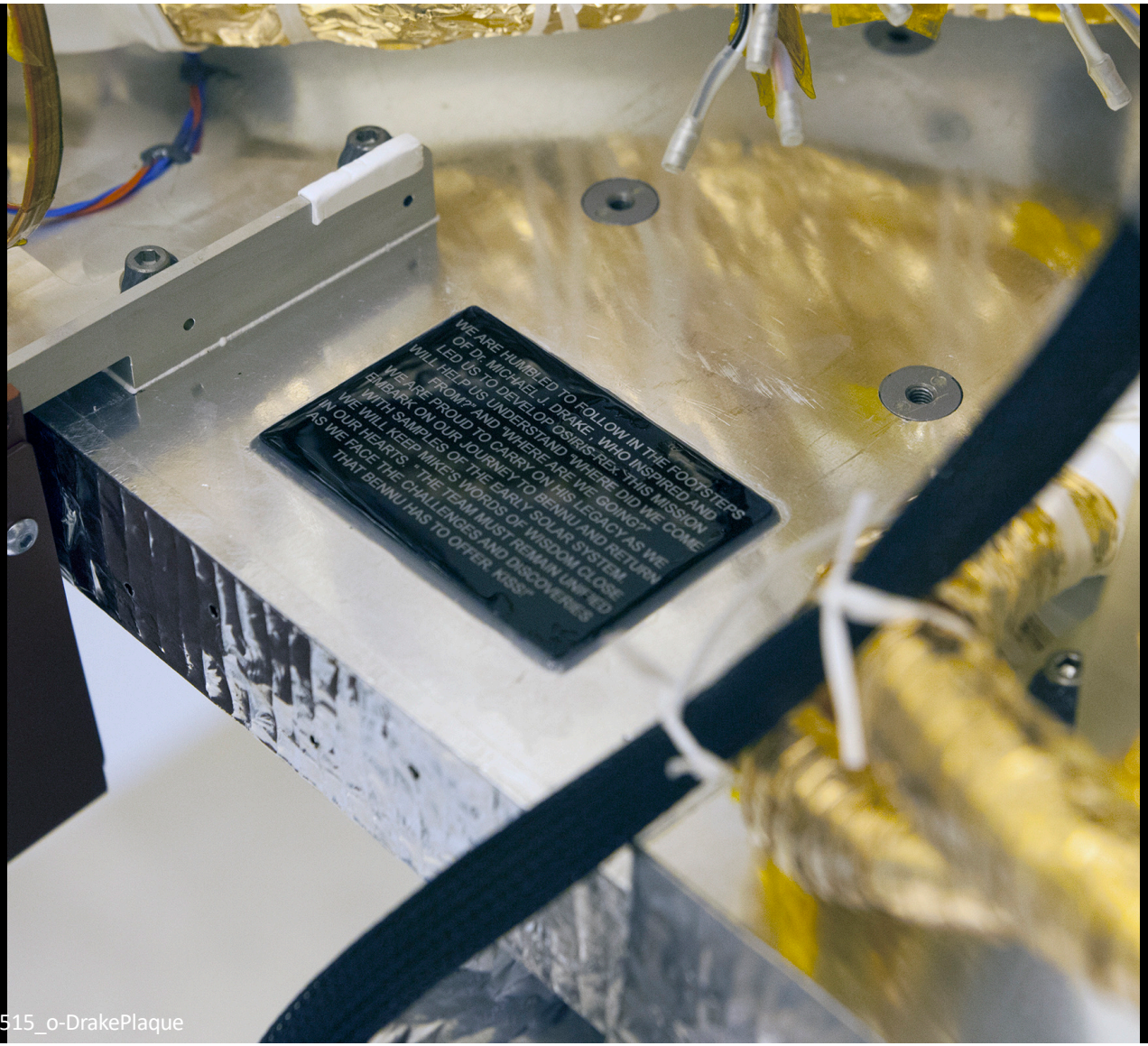


Sampling the Solar System: Insights from the OSIRIS-REx Mission

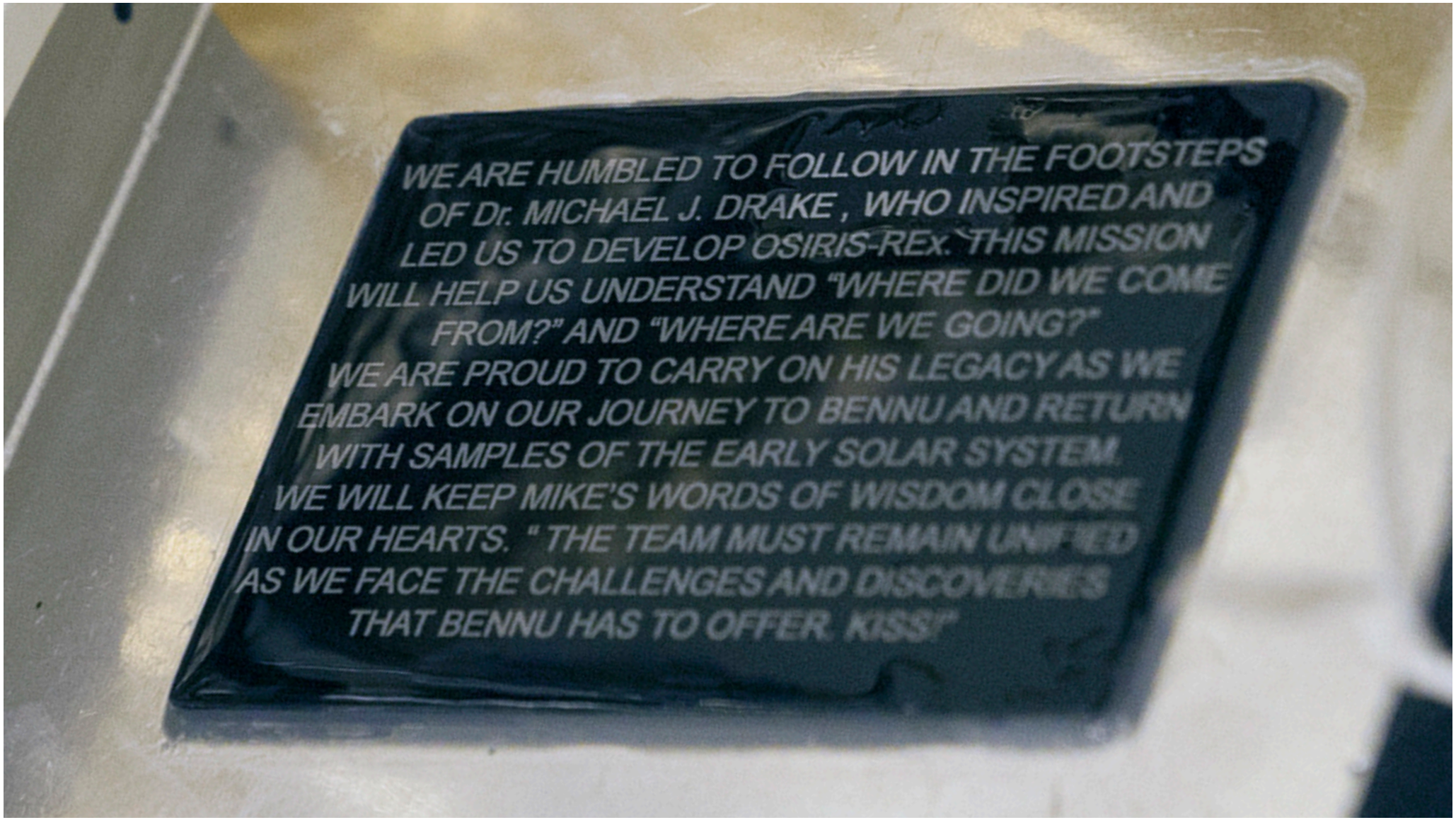
Jason Dworkin
OSIRIS-REx Project Scientist
NASA's Goddard Space Flight Center

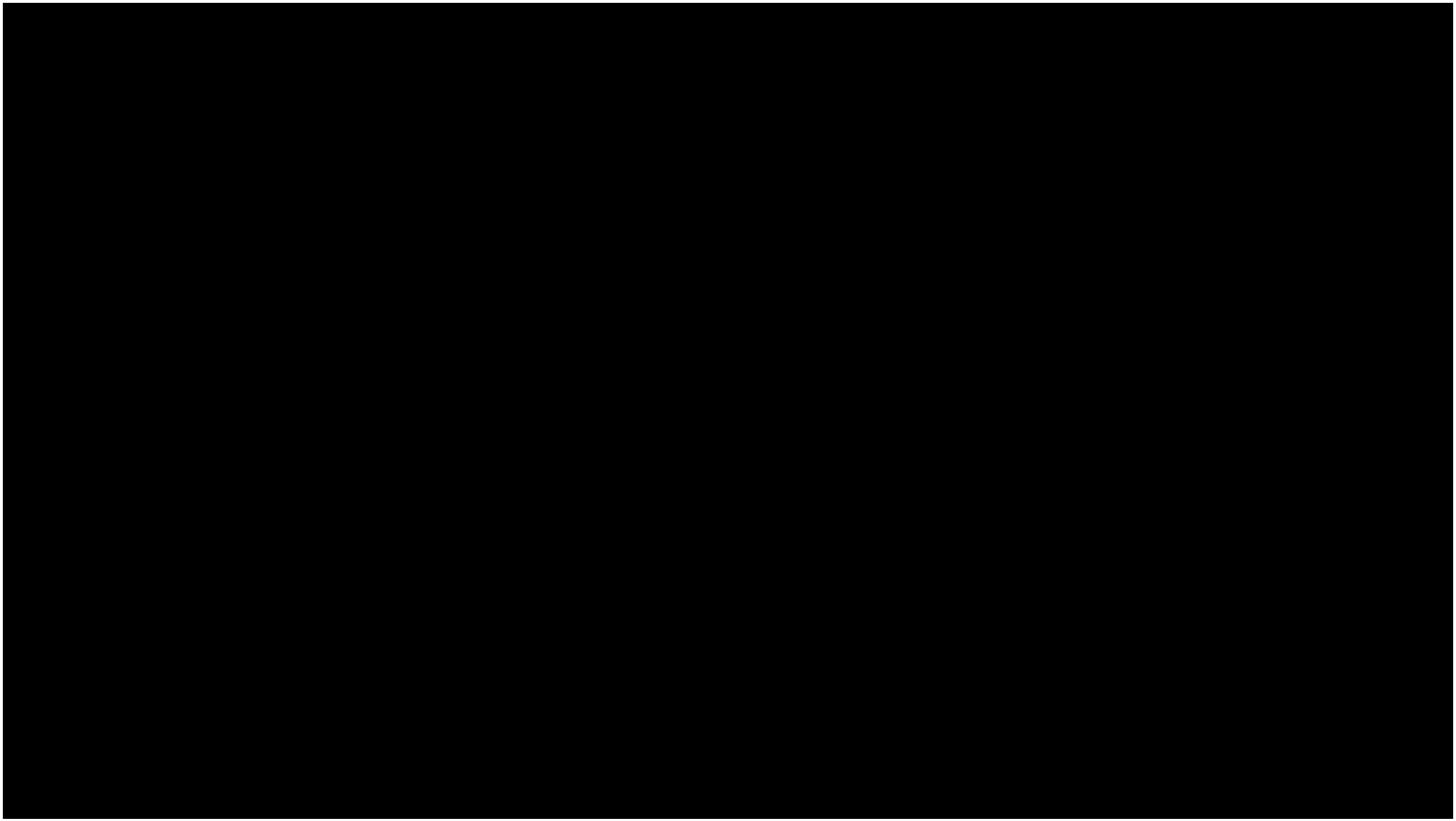
10 October 2024

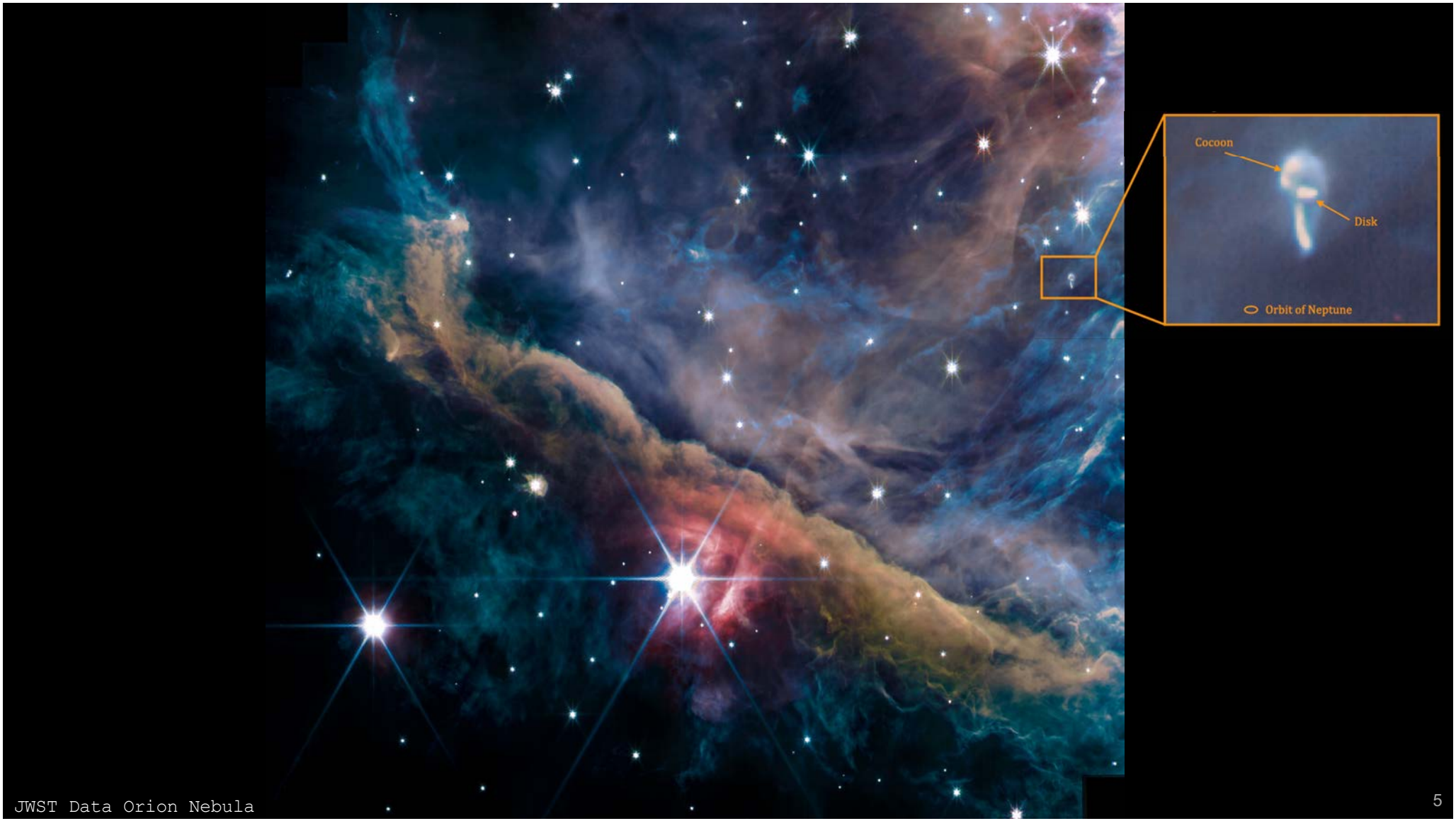
Derived from Flight Data



ksc-20160718-ph_csh01_0040_28767006515_o-DrakePlaque


WE ARE HUMBLED TO FOLLOW IN THE FOOTSTEPS
OF Dr. MICHAEL J. DRAKE , WHO INSPIRED AND
LED US TO DEVELOP OSIRIS-REx. THIS MISSION
WILL HELP US UNDERSTAND "WHERE DID WE COME
FROM?" AND "WHERE ARE WE GOING?"
WE ARE PROUD TO CARRY ON HIS LEGACY AS WE
EMBARK ON OUR JOURNEY TO BENNU AND RETURN
WITH SAMPLES OF THE EARLY SOLAR SYSTEM.
WE WILL KEEP MIKE'S WORDS OF WISDOM CLOSE
IN OUR HEARTS. " THE TEAM MUST REMAIN UNIFIED
AS WE FACE THE CHALLENGES AND DISCOVERIES
THAT BENNU HAS TO OFFER. KISS!"





JWST Data Orion Nebula


Artistic Interpretation NASA's Goddard Space Flight Center Conceptual Image Lab

Geologists have a saying – rocks remember.

Extraterrestrial Samples

Geoff Notkin and Steve Arnold

"Alpha" Kansas, USA Brenham Strewn Field

Muawia Shaddad, Peter Jenniskens, and U. Khartoum students

Nubian Desert, Sudan. Almahata Sitta Fall

Scott Messenger and Danny Glavin with Dante Lauretta (background)

MacAlpine Hills, Antarctica ANSMET

NASA's OSIRIS-REx mission collected 250±101gg of asteroid Bennu surface to return to Earth

More contaminated
Worse documented

Less contaminated
Better documented

Sample Return Missions: The gift that keeps on giving

Moon

- NASA *Apollo* 11, 12, 14, 15, 16, and 17 (1969, 1971, 1972)
- Soviet Luna 16, 20, and 24 (1970, 1972, 1976)
- China Chang'e 5, 6 (2020, 2024)
- NASA *Artemis III, etc.* (in development, 2026)

Solar wind

- NASA Genesis (returned 2004)

Comet tail

- NASA Stardust (returned 2006)

Stony Asteroid

- JAXA Hayabusa (returned 2010)

Carbonaceous Asteroid

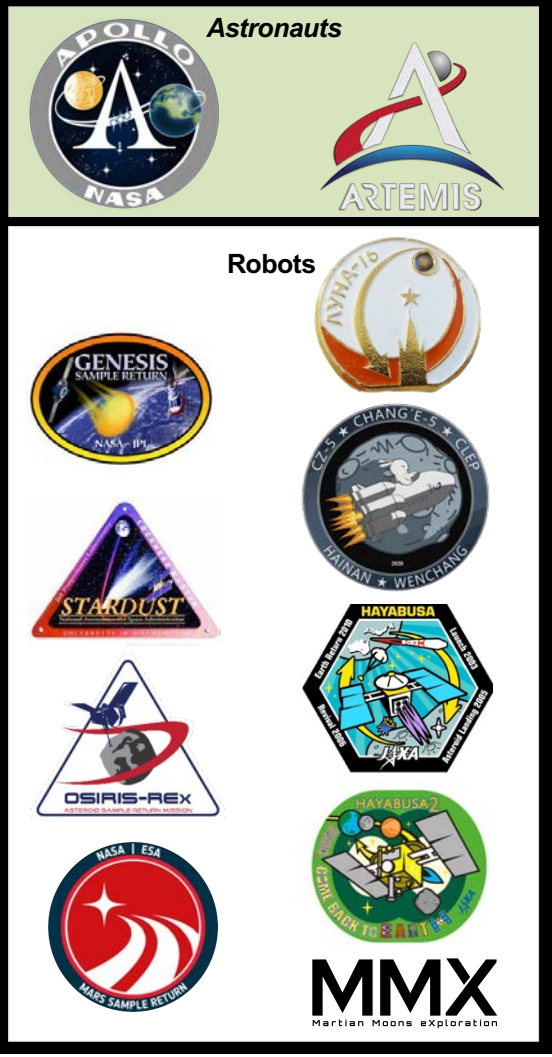
- JAXA Hayabusa2 (returned 2020)
- NASA OSIRIS-REx (returned 2023)

Phobos

- JAXA MMX (in development, 2026-2030)

Mars

- NASA/ESA MSR (in development, 2020-)



OSIRIS-REx

Origins

Return and analyze a sample of pristine carbonaceous asteroid regolith

Spectral Interpretation

Provide ground truth for telescopic data of the entire asteroid population

Resource Identification

Map the chemistry and mineralogy of a primitive carbonaceous asteroid

Security

Measure the Yarkovsky effect on a potentially hazardous asteroid

Regolith Explorer

Document the regolith at the sampling site at scales down to the sub-cm

TAGSAM (LM)
Collects the sample

REXIS (MIT) Student Experiment maps the elemental abundances

SRC (LM) Returns the sample

OCAMS (UA) **PolyCam** >500K-km range, high-resolution imaging of the surface, **SamCam** images the sample site and TAG, **MapCam** provides landmark-tracking, filter photometry.

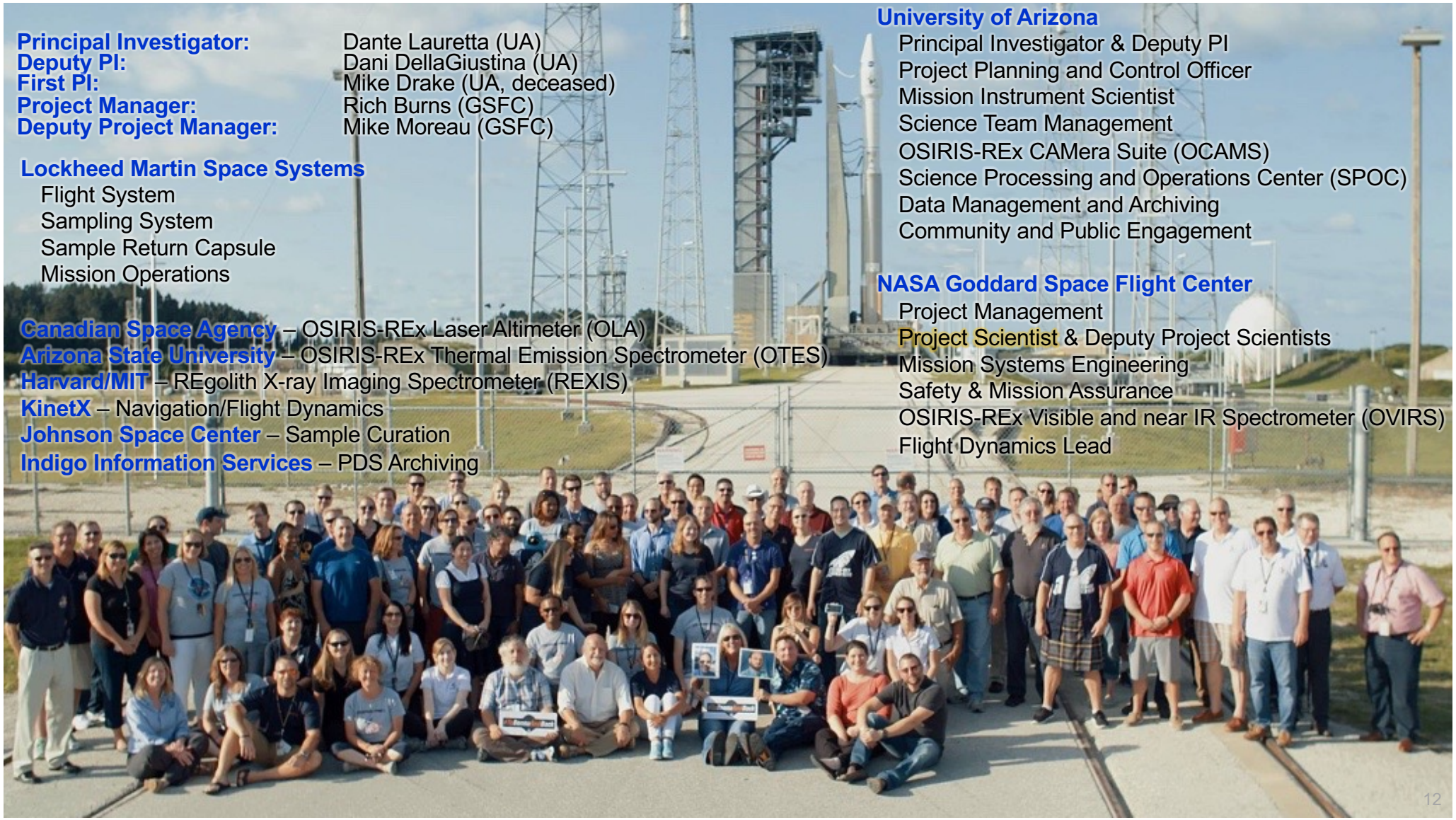
OTES (ASU) maps the thermal flux and spectra from 5 – 50 µm

OVIRS (GSFC) maps the reflectance albedo and spectra from 0.4 – 4.3 µm

OLA (CSA) ranging to 7 km and maps the asteroid shape and surface topography

NavCams (MSSS)
navigates the surface of Bennu

Highly capable, nimble spacecraft



Principal Investigator: Dante Lauretta (UA)
Deputy PI: Dani DellaGiustina (UA)
First PI: Mike Drake (UA, deceased)
Project Manager: Rich Burns (GSFC)
Deputy Project Manager: Mike Moreau (GSFC)

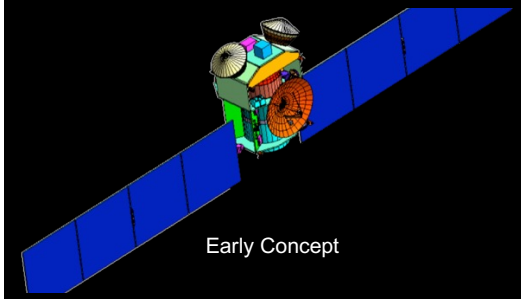
Lockheed Martin Space Systems
- Flight System
- Sampling System
- Sample Return Capsule
- Mission Operations

Canadian Space Agency – OSIRIS-REx Laser Altimeter (OLA)
Arizona State University – OSIRIS-REx Thermal Emission Spectrometer (OTES)
Harvard/MIT – REgolith X-ray Imaging Spectrometer (REXIS)
KinetX – Navigation/Flight Dynamics
Johnson Space Center – Sample Curation
Indigo Information Services – PDS Archiving

University of Arizona
- Principal Investigator & Deputy PI
- Project Planning and Control Officer
- Mission Instrument Scientist
- Science Team Management
- OSIRIS-REx CAMera Suite (OCAMS)
- Science Processing and Operations Center (SPOC)
- Data Management and Archiving
- Community and Public Engagement

NASA Goddard Space Flight Center
- Project Management
- Project Scientist & Deputy Project Scientists
- Mission Systems Engineering
- Safety & Mission Assurance
- OSIRIS-REx Visible and near IR Spectrometer (OVIRS)
- Flight Dynamics Lead

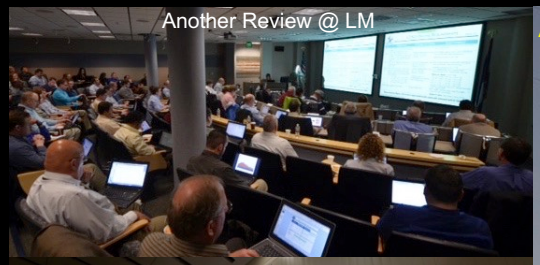
Path to Launch



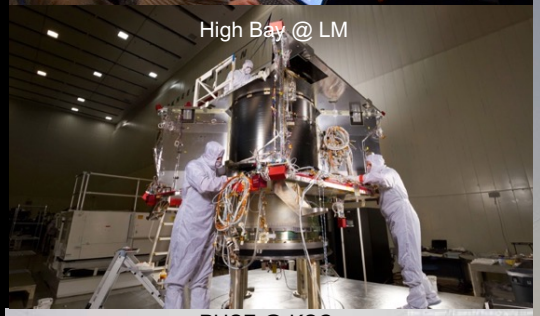
Early Concept

Volume 2 of the Step 2 Proposal

Discovery 11 Proposal	July 16, 2004
Non-selection	Feb 2, 2005
Discovery 12 Proposal	Mar 27, 2006
Down Select (KDP-A)	Oct 30, 2006
Step 2 Proposal	June 20, 2007
Site Visit	Aug 21, 2007
Non-selection	Dec 11, 2007
New Frontiers 3 Proposal	July 31, 2009
Down Select (KDP-A)	Dec 17, 2009
Step 2 Proposal	Jan 28, 2011
Site Visit	Apr 14, 2011
Selection (KDP-B)	May 25, 2011
MDR	May 8-10, 2012
PDR	Mar 4-8, 2013
Confirmation (KDP-C)	June 1, 2013
CDR (KDP-D)	Apr 1-9, 2014
Start of ATLO	March 23, 2015
PER	Oct 14-16, 2015
PSR	May 10-11, 2016
Ship to KSC	May 20, 2016
FOR / ORR	Jun 21-24, 2016
SMSR	Aug 9, 2016
MRB / KDP-E	Aug 18, 2016
FRR	Sep 1, 2016
LRR	Sep 6, 2016
Launch	Sep 8, 2016

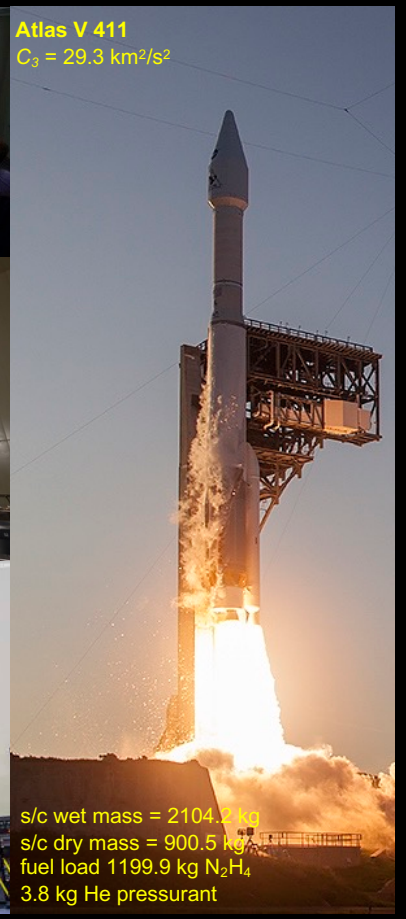


Another Review @ LM



High Bay @ LM

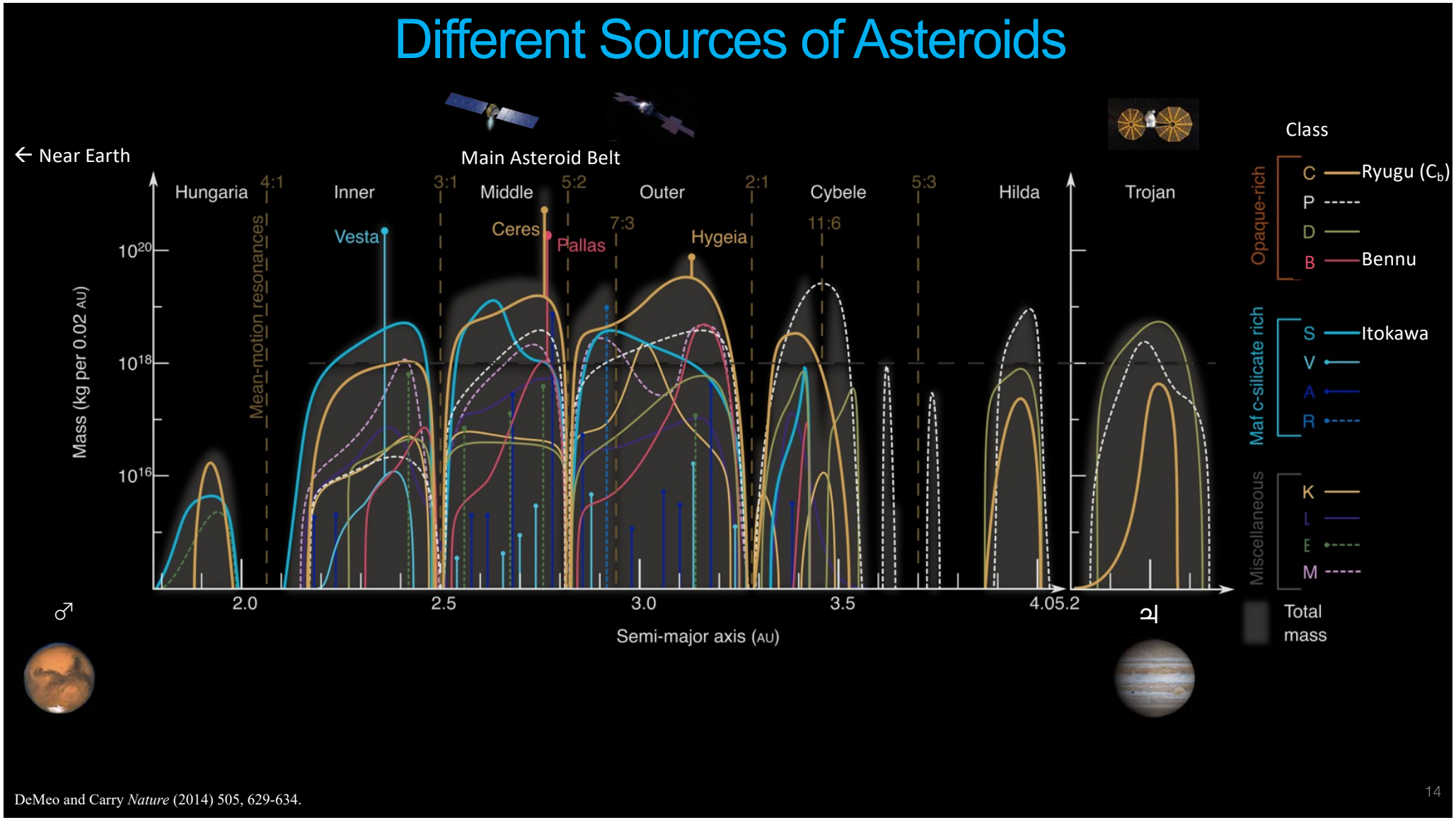
PHSF @ KSC



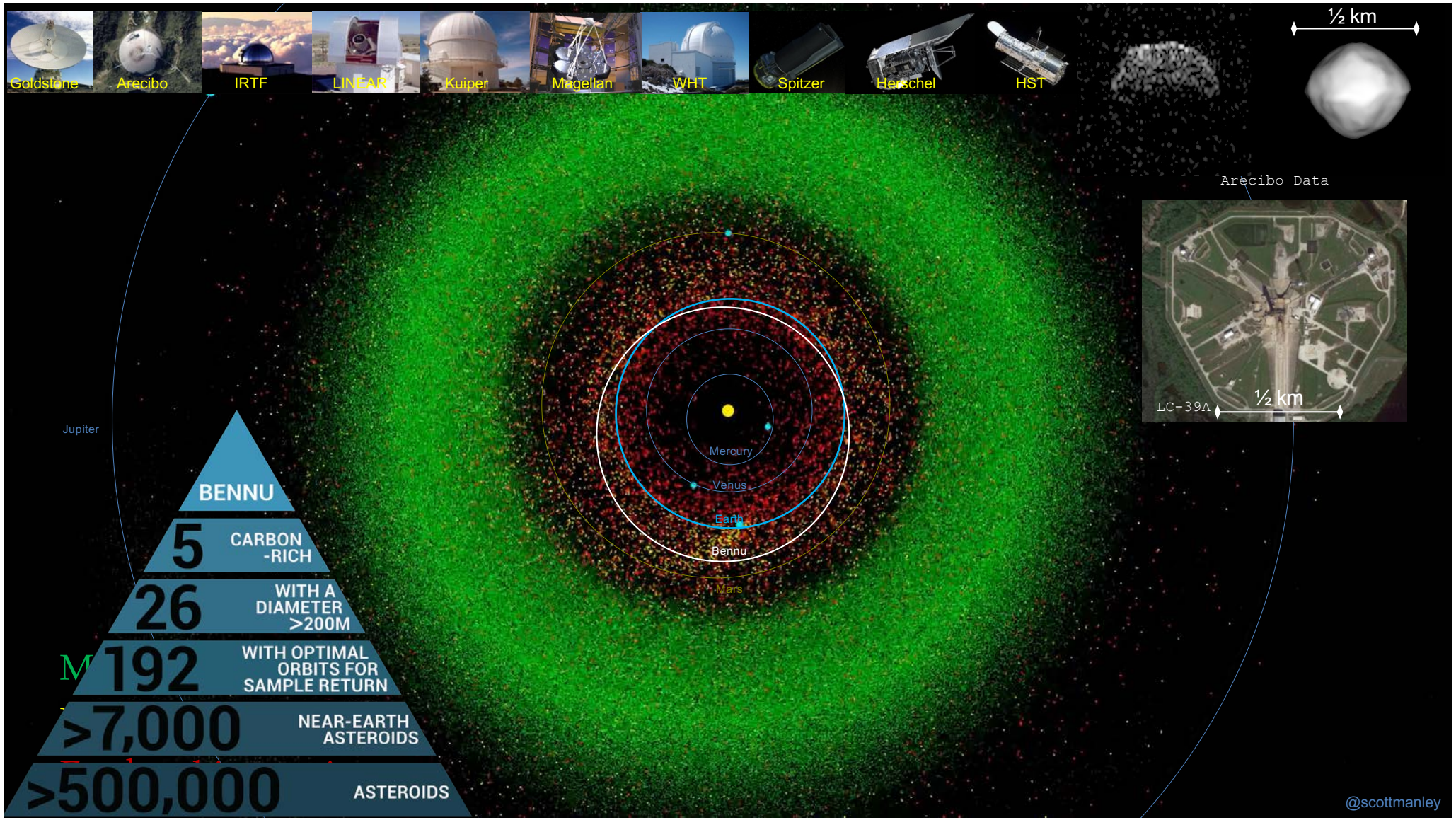
Atlas V 411
C_3 = 29.3 km²/s²

s/c wet mass = 2104.2 kg
s/c dry mass = 900.5 kg
fuel load 1199.9 kg N_2H_4
3.8 kg He pressurant

Different Sources of Asteroids

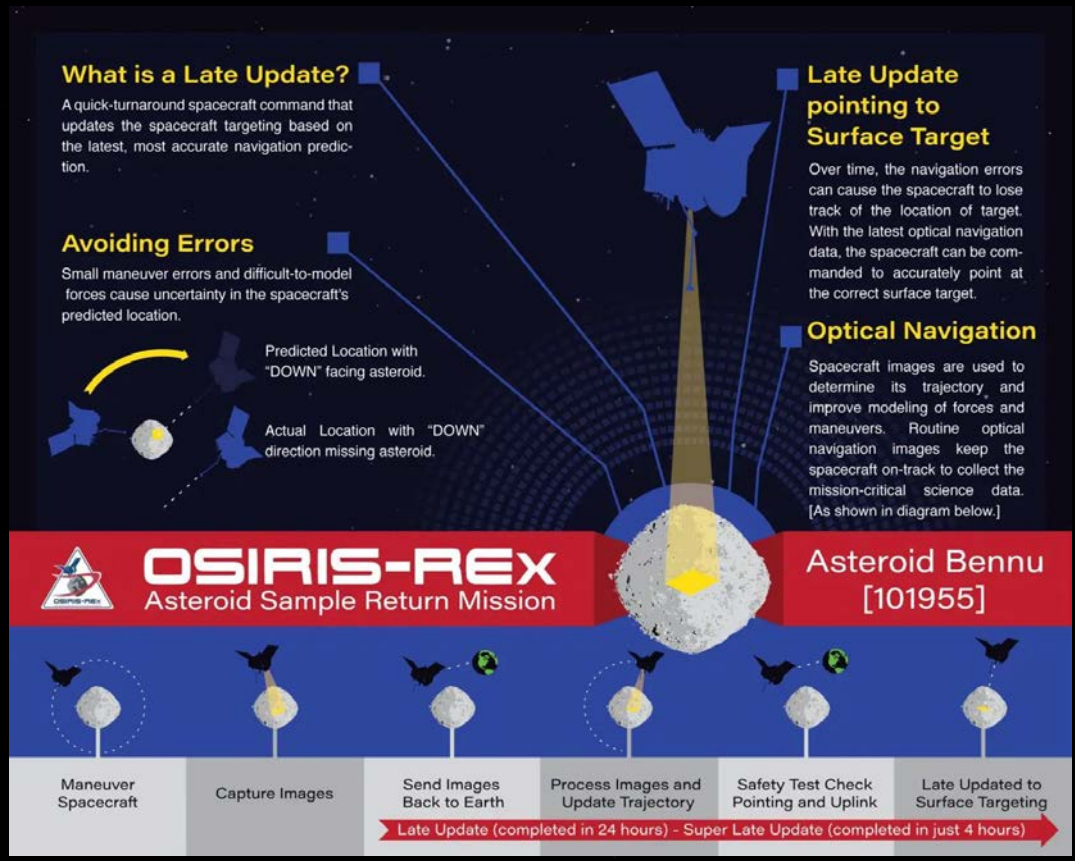


DeMeo and Carry *Nature* (2014) 505, 629-634.


Goldstone
Arecibo
IRTF
LINEAR
Kuiper
Magellan
WHT
Spitzer
Herschel
HST
½ km
Arecibo Data
LC-39A
½ km
Jupiter
Mercury
Venus
Earth
Bennu
Mars
BENNU
5 CARBON -RICH
26 WITH A DIAMETER >200M
192 WITH OPTIMAL ORBITS FOR SAMPLE RETURN
>7,000 NEAR-EARTH ASTEROIDS
>500,000 ASTEROIDS
@scottmanley

Complex flight dynamics at a small body

- Smallest maneuver 0.1 mm/s; largest 431 m/s
- 10 orbit insertions; 127 deep space maneuvers
- First frozen orbit at a small body
- 37k optical navigation images
- Lowest orbit (832 m semimajor axis) around smallest object (490 m ave.)
- One safe mode in 7 years (human error outbound cruise)



Madrid DSN Outage
10/11/19

Derived from Flight Data

https://svs.gsfc.nasa.gov/4905

Complex flight dynamics at a small body

- Smallest maneuver 0.1 mm/s; largest 431 m/s
- 10 orbit insertions; 127 deep space maneuvers
- First frozen orbit at a small body
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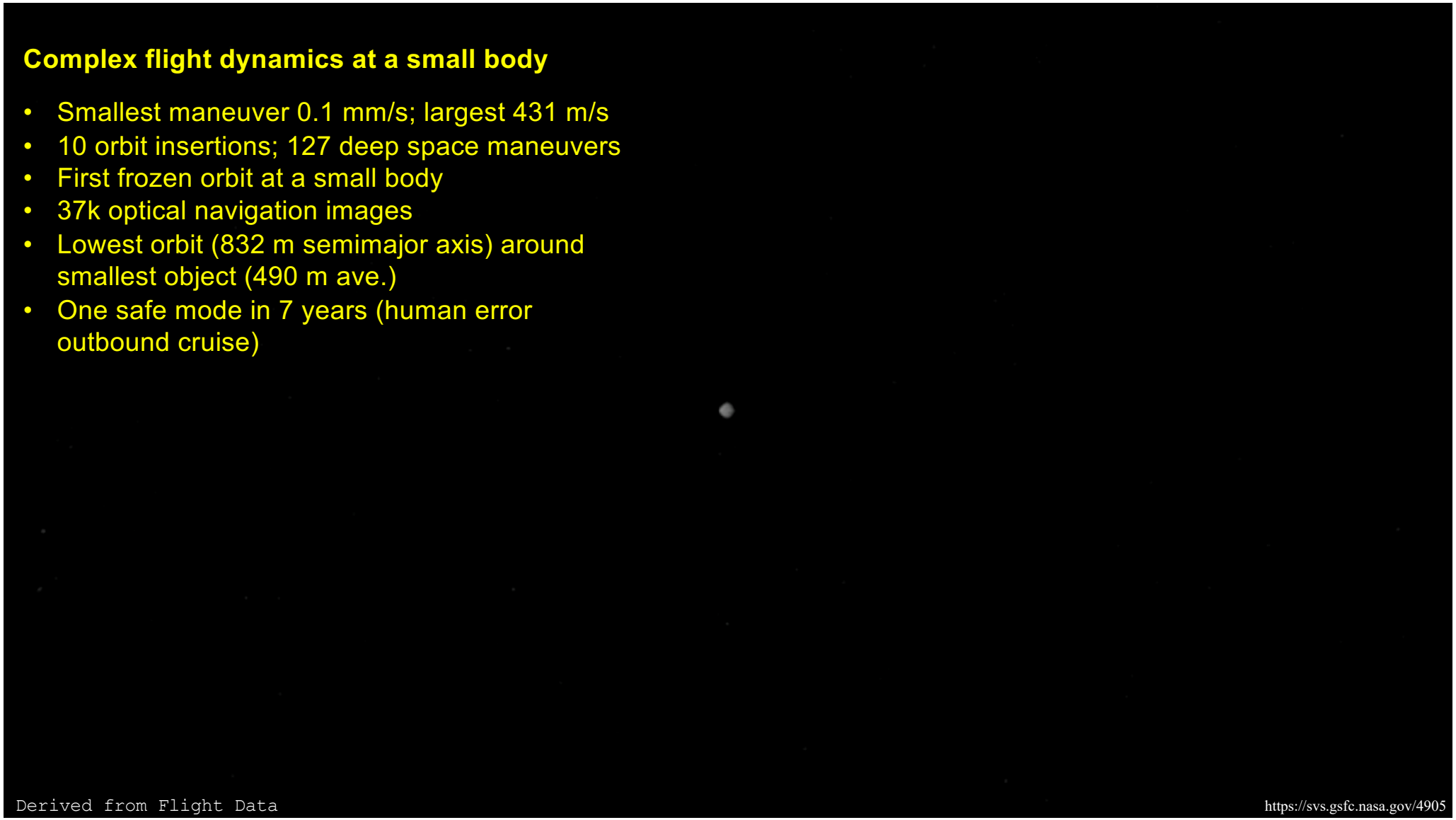


Derived from Flight Data

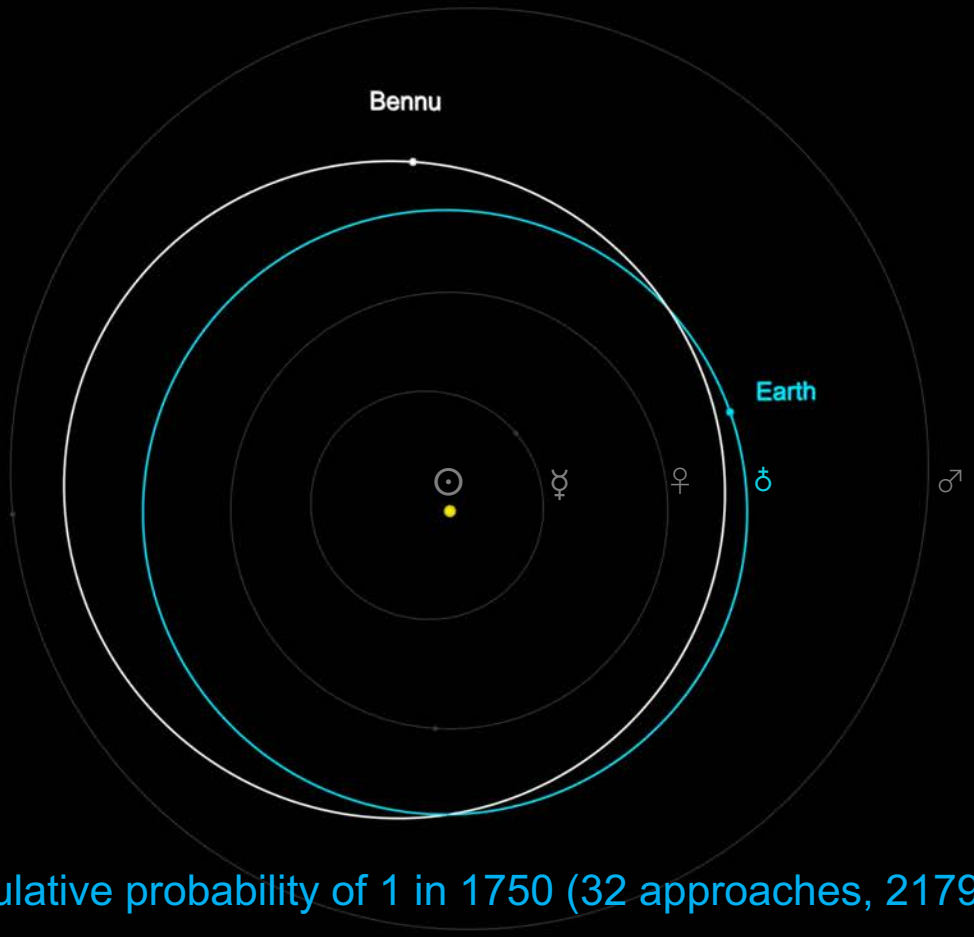
https://svs.gsfc.nasa.gov/4905

Particle ejections

Physical properties: interior voids, 8μg, 1.19 g/mL density

Derived from Flight Data

Refined Bennu impact probability

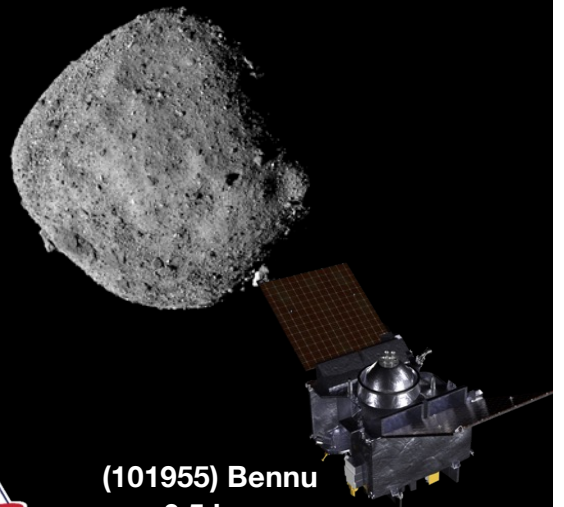


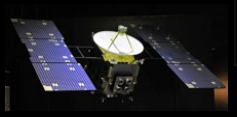
Jan 2135

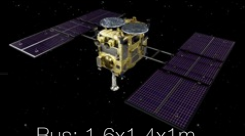
Cumulative probability of 1 in 1750 (32 approaches, 2179-2300)

Simulation

Comparing Asteroids

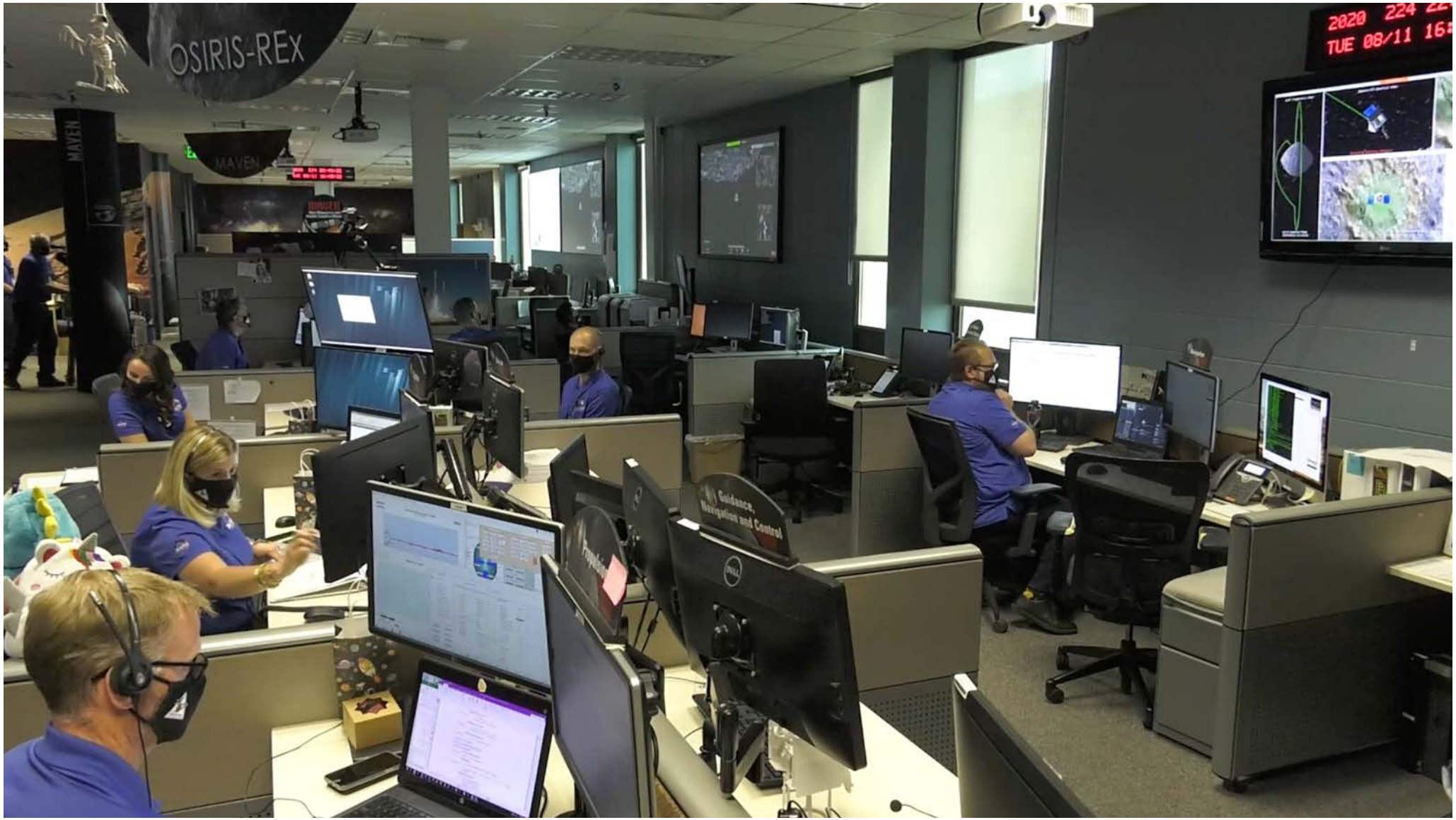




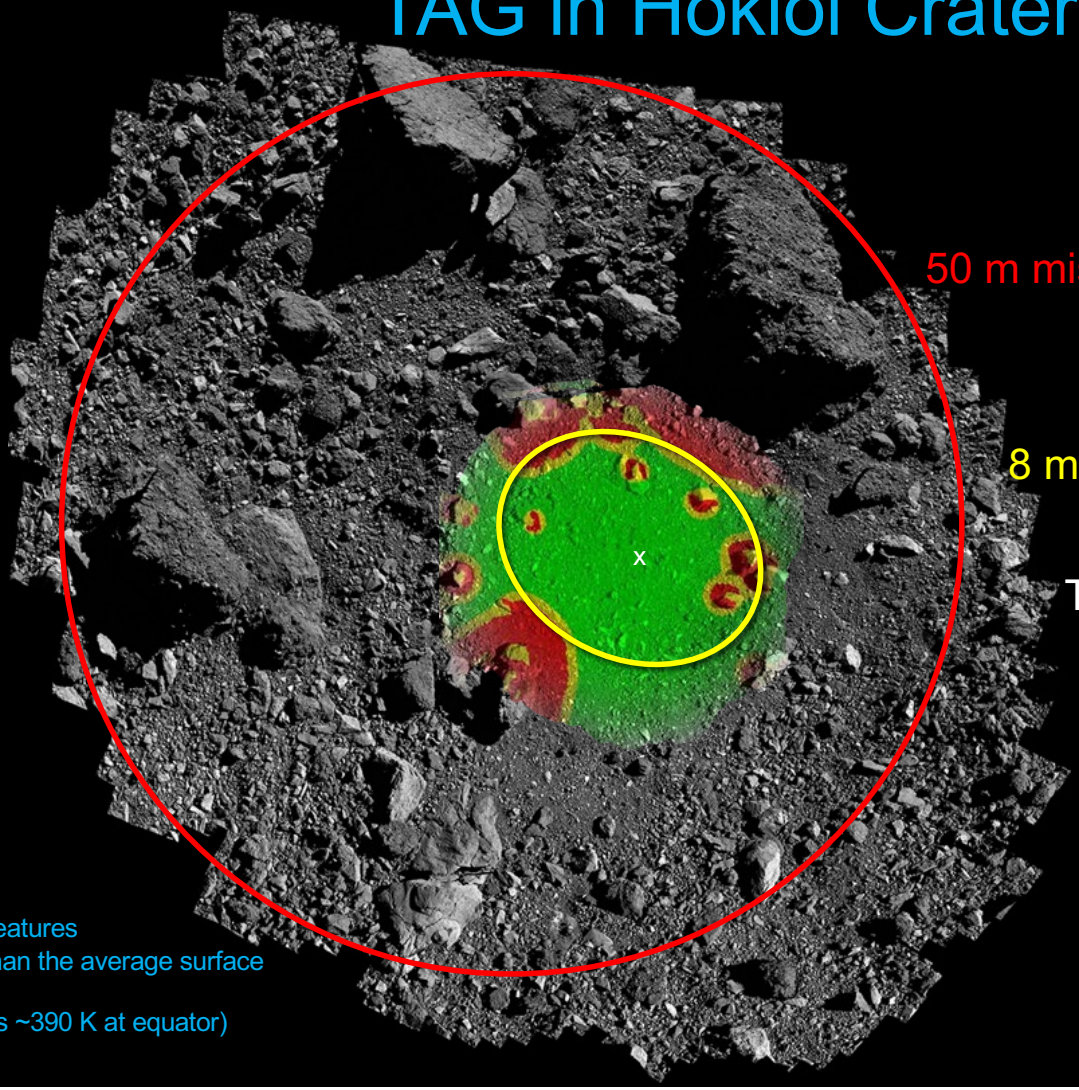


(25143) Itokawa **0.5 x 0.3 x 0.2 km** **Hayabusa 2005** Bus: 1.5x1.5x1m Wet mass: 530 kg		**(162173) Ryugu** **1 km** **Hayabusa2 2018** Bus: 1.6x1.4x1m Wet mass: 600 kg		**(101955) Bennu** **0.5 km** **OSIRIS-REx 2018** Bus: 3.1x3.1x2.7m Wet mass: 1529 kg
½x¼x¼ km Rubble Pile, Bilobar, 2 Spin Axes	X	1 km Rubble Pile, Spinning Top, Retrograde	✓	½ km Rubble Pile, Spinning Top, Retrograde
Earth-Crossing, 1.32 AU Semimajor Axis	X	Earth-Crossing, 1.19 AU Semimajor Axis	✓	Earth-Crossing, 1.13 AU Semimajor Axis
Flora Dynamical Family	X	Eulalia or Polana Dynamical Family	✓	Eulalia or Nysa-Polana Dynamical Family
1.9 g/mL	X	1.19 g/mL	✓	1.19 g/mL
23% Albedo, Class S	X	4.4% Albedo, Class C_b	✓	4.6% Albedo, Class B
Dehydrated pyroxenes	X	Dehydrated phyllosilicates, carbonate	~	Hydrated phyllosilicates, carbonate, pyroxene xenoliths

After Oba, et al. (2023) *Nature Communications*, 14: 3107


OSIRIS-REx
MAVEN
Guidance, Navigation and Control

TAG in Hokioi Crater



50 m mission design TAG ellipse

8 m TAG ellipse at Nightingale site

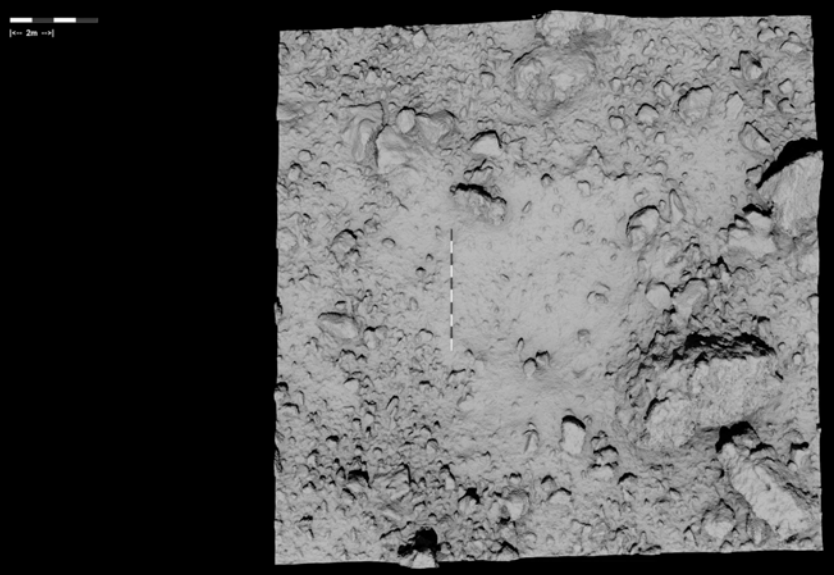
TAG 73 cm from center

Among the youngest impact features
Spectrally redder in VISNIR than the average surface
Mid-latitude (56˚,43˚) location
Limited peak T ~360 K (versus ~390 K at equator)

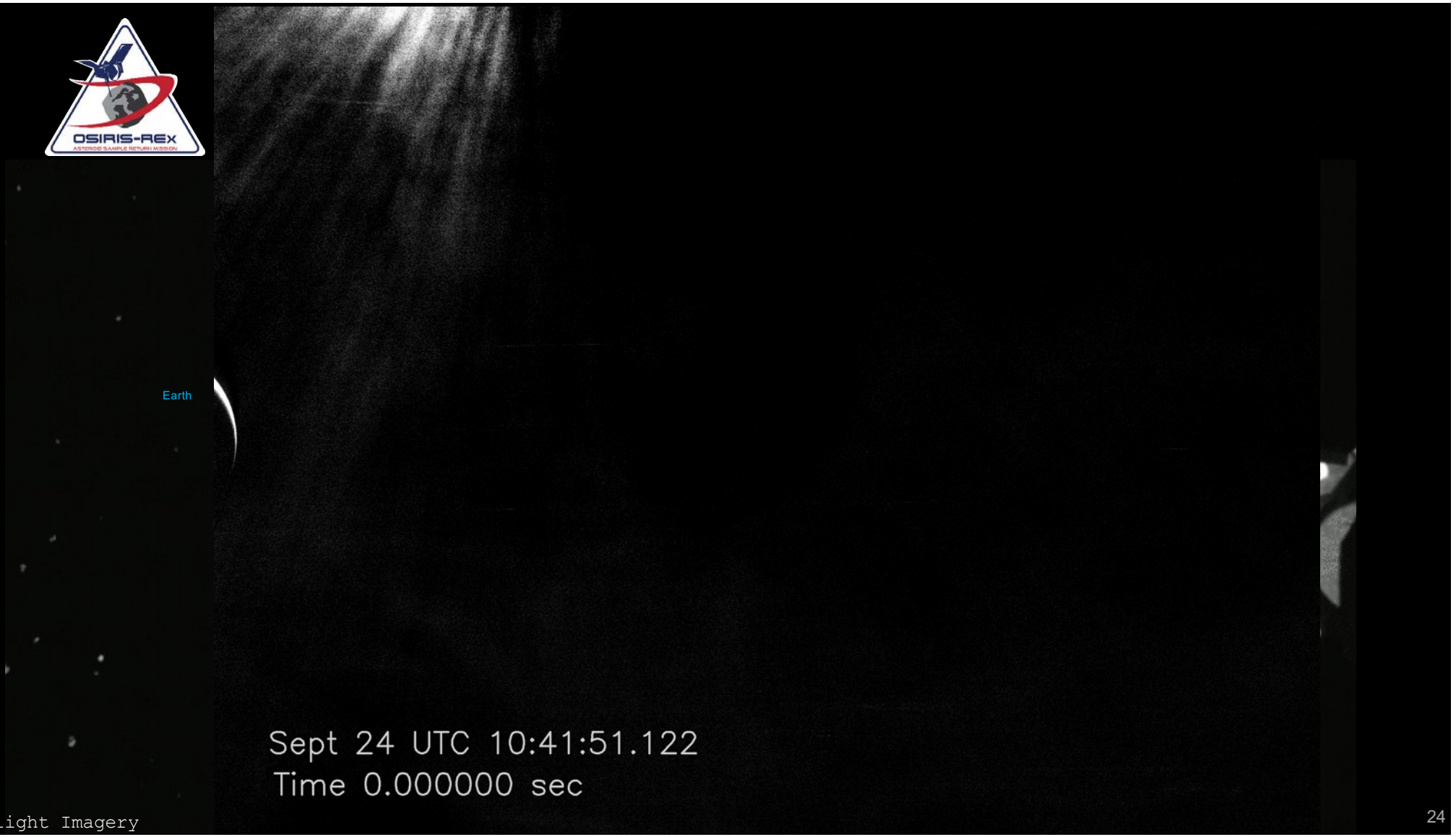
Flight Imagery

TAG Crater

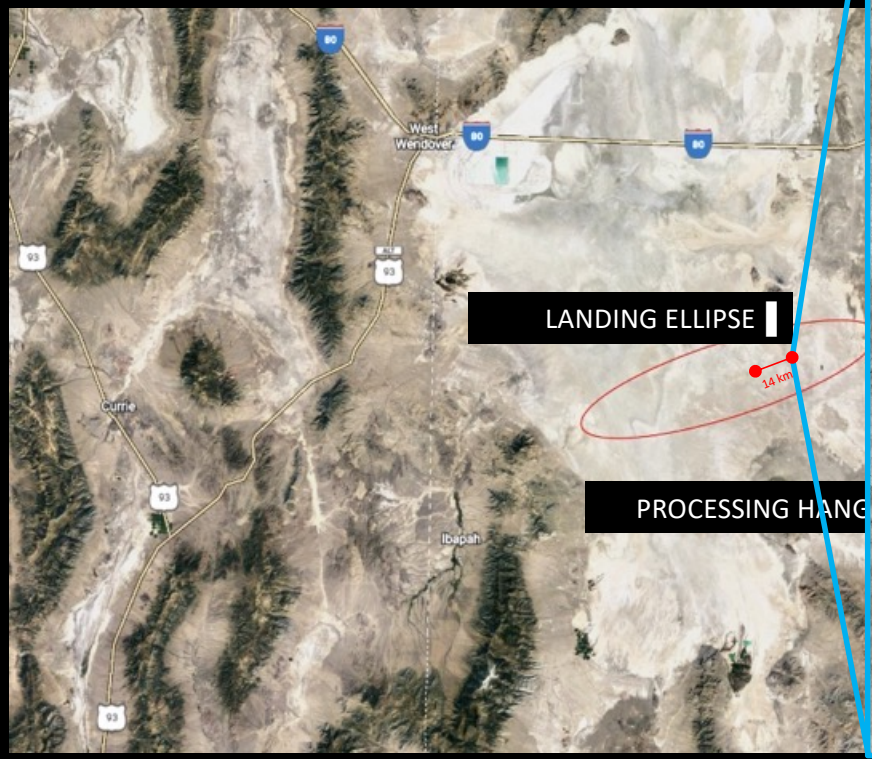
- Applied stereophotoclinometry to construct a 5-cm terrain model
- Crater: 9.0 × 6.5 m
  0.68 ± 0.1 m deep
- Displaced volume is 12.2 ± 0.9 m^3
- Bulk density of 500 to 700 kg/m^3
- Nearly cohesionless (<0.001 Pa) granular material



Derived from Flight Data



Flight Imagery


West Wendover
Currie
Ibapah
LANDING ELLIPSE
14 km
PROCESSING HANG


Bennu SRC landing site


Safe
Purge
Document
Fly
Bag
Helicopter
Secure
Receive

121.6g of sample

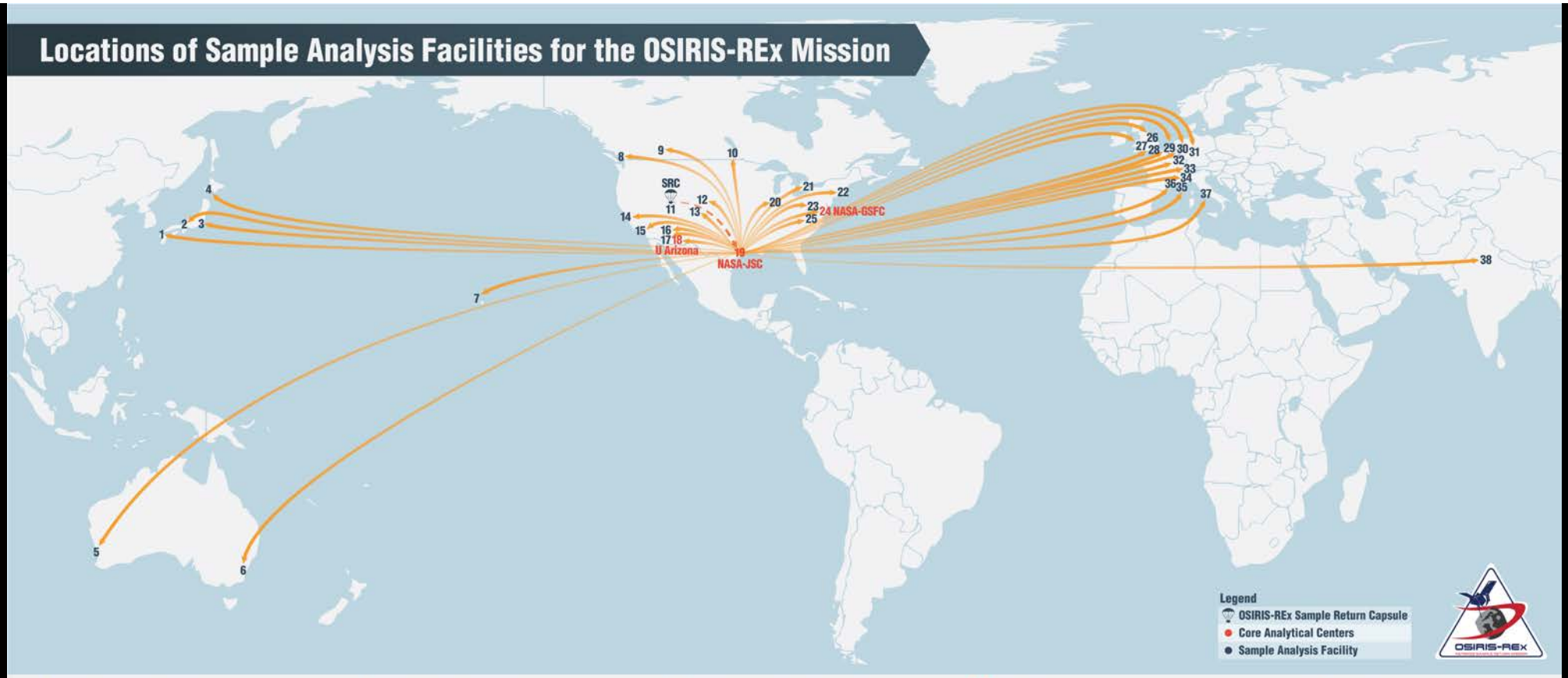
Requirement: Collect and return 60g from asteroid Bennu

~50g

~70g

~1g

Locations of Sample Analysis Facilities for the OSIRIS-REx Mission

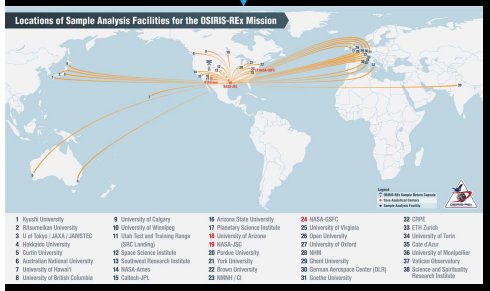


1 Kyushi University
2 Ritsumeikan University
3 U of Tokyo / JAXA / JAMSTEC
4 Hokkaido University
5 Curtin University
6 Australian National University
7 University of Hawai'i
8 University of British Columbia
9 University of Calgary
10 University of Winnipeg
11 Utah Test and Training Range (SRC Landing)
12 Space Science Institute
13 Southwest Research Institute
14 NASA-Ames
15 Caltech-JPL
16 Arizona State University
17 Planetary Science Institute
18 University of Arizona
19 NASA-JSC
20 Purdue University
21 York University
22 Brown University
23 NMNH / CI
24 NASA-GSFC
25 University of Virginia
26 Open University
27 University of Oxford
28 NHM
29 Ghent University
30 German Aerospace Center (DLR)
31 Goethe University
32 CRPE
33 ETH Zurich
34 University of Turin
35 Cote d'Azur
36 University of Montpellier
37 Vatican Observatory
38 Science and Spirituality Research Institute

Sample Distribution

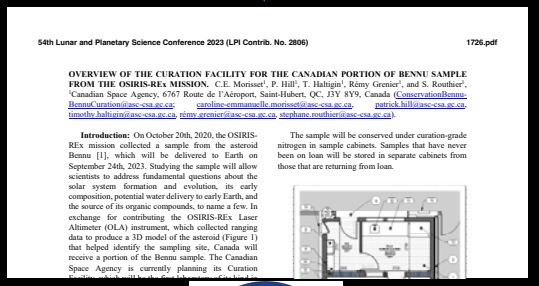
121.6g &
24 contact pads

Up to 25%
(14% planned)



0.55% &
1 contact pad

4% &
1 contact pad



54th Lunar and Planetary Science Conference 2023 (LPI Contrib. No. 2806) 1726.pdf

OVERVIEW OF THE CURATION FACILITY FOR THE CANADIAN PORTION OF BENNU SAMPLE FROM THE OSIRIS-REx MISSION. C.E. Morisset[1], P. Hill[1], T. Haltigin[1], Rémy Grenier[1], and S. Routhier[1], [1]Canadian Space Agency, 6767 Route de l'Aéroport, Saint-Hubert, QC, J3Y 8Y9, Canada (ConservationBennu-BennuCuration@asc-csa.gc.ca; caroline-emmanuelle.morisset@asc-csa.gc.ca, patrick.hill@asc-csa.gc.ca, timothy.haltigin@asc-csa.gc.ca, rémy.grenier@asc-csa.gc.ca, stephane.routhier@asc-csa.gc.ca).

Introduction: On October 20th, 2020, the OSIRIS-REx mission collected a sample from the asteroid Bennu [1], which will be delivered to Earth on September 24th, 2023. Studying the sample will allow scientists to address fundamental questions about the solar system formation and evolution, its early composition, potential water delivery to early Earth, and the source of its organic compounds, to name a few. In exchange for contributing the OSIRIS-REx Laser Altimeter (OLA) instrument, which collected ranging data to produce a 3D model of the asteroid (Figure 1) that helped identify the sampling site, Canada will receive a portion of the Bennu sample. The Canadian Space Agency is currently planning its Curation

The sample will be conserved under curation-grade nitrogen in sample cabinets. Samples that have never been on loan will be stored in separate cabinets from those that are returning from loan.

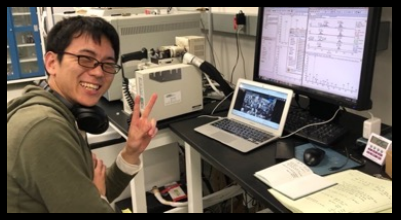
≥70%
(Remainder)

Sample Science

Fourier Transform Infrared Microscopy

2D Gas Chromatography High Resolution Mass Spectrometry

Liquid Chromatography Fourier Transform Mass Spectrometry



Gas Chromatography Mass Spectrometry

Compound Specific Isotopic Ratio Mass Spectrometry

Transmission Electron Microscopy

Electron Microprobe Analysis

Inductively Coupled Plasma Mass Spectrometry

Nanoscale Secondary Ion Mass Spectrometry

Visible Light Microscopy

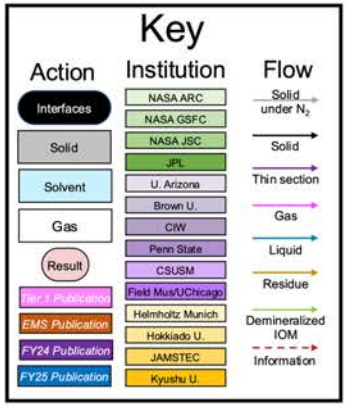
Scanning-Electron Microscopy Energy-Dispersive X-ray Spectroscopy

X-ray Absorption Near-Edge Structure Spectroscopy

Accelerator Mass Spectrometry

70% for the Future

Sample Analysis Plan (Organics Only)



Notes

EMS = Early Mission Science
IOM = Insoluble Organic Material
PAH = Polycyclic Aromatic Hydrocarbon
SOM = Soluble Organic Material
Participating Scientist sample allocation
Undefined/TBD
Avionics sample has been allocated and mass accounted, parent OREX-500002-0 (22 mg)
Avionics sample has been allocated and mass accounted, parent OREX-500002-0 (6 mg)
Aggregate sample has been allocated and mass accounted, parent OREX-800031-0 (55 mg)
Aggregate sample has been allocated from MAPWG, parent OREX-800044-101 (18 mg)
Aggregate sample has been allocated and mass accounted, parent OREX-800107-0 (6425 mg)
Aggregate samples have been allocated and mass accounted, parents OREX-8000007-0 (326 mg)
Angular SOI OREX-800055-3 (49 mg)
Hummocky SOI OREX-800088-3 (38 mg)
Future mottled SOI OREX-800023-0 (~60 mg)
Some analyses overlap with Elements and Isotopes Analysis Plan

Total mass counted against SOAWG:
6425-(0.0488+.06944+.01086+.09081)+22+6+55+49+38+121+205 = 6920.78 mg of 7784 = 88.9%

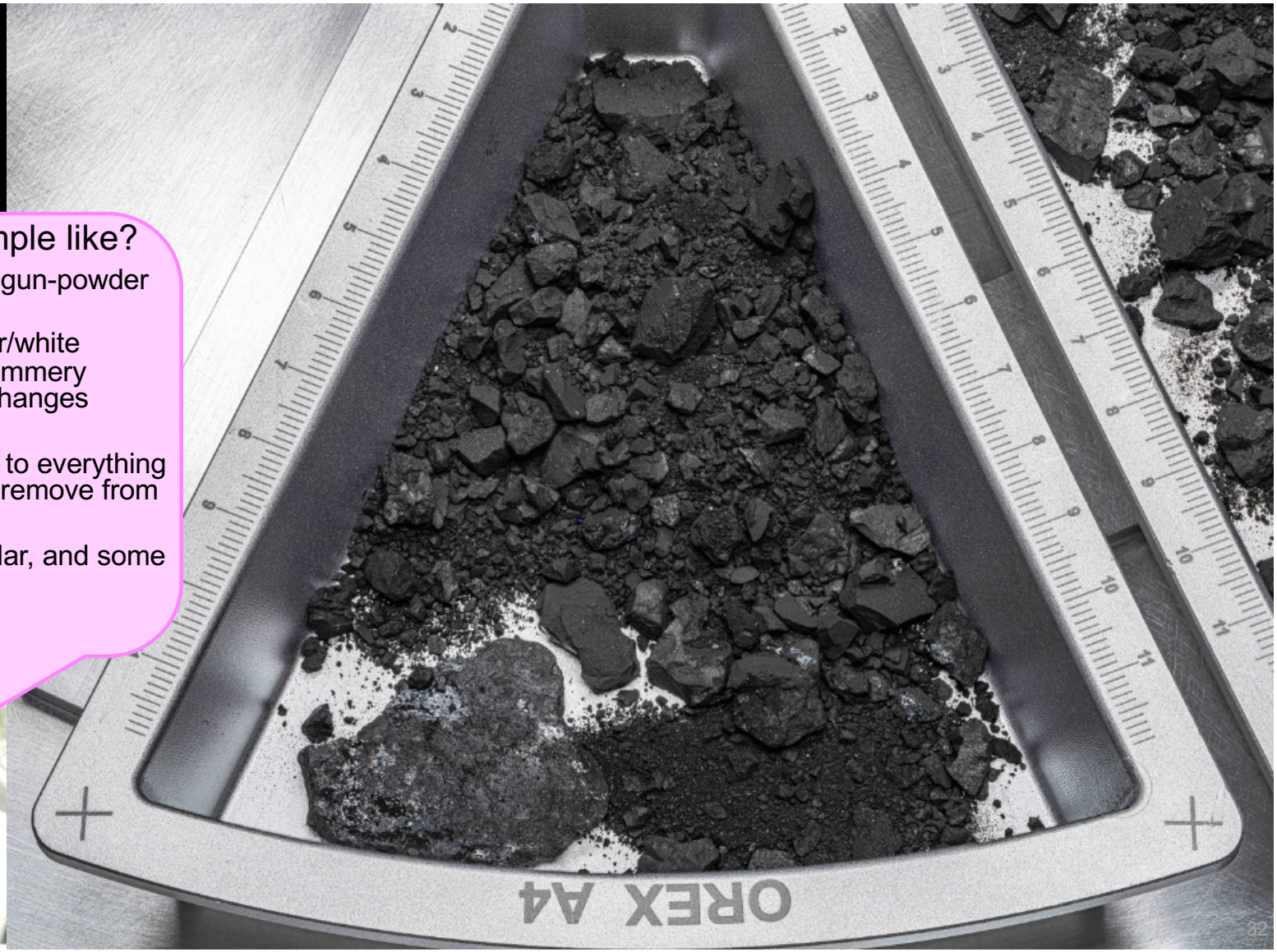
Techniques

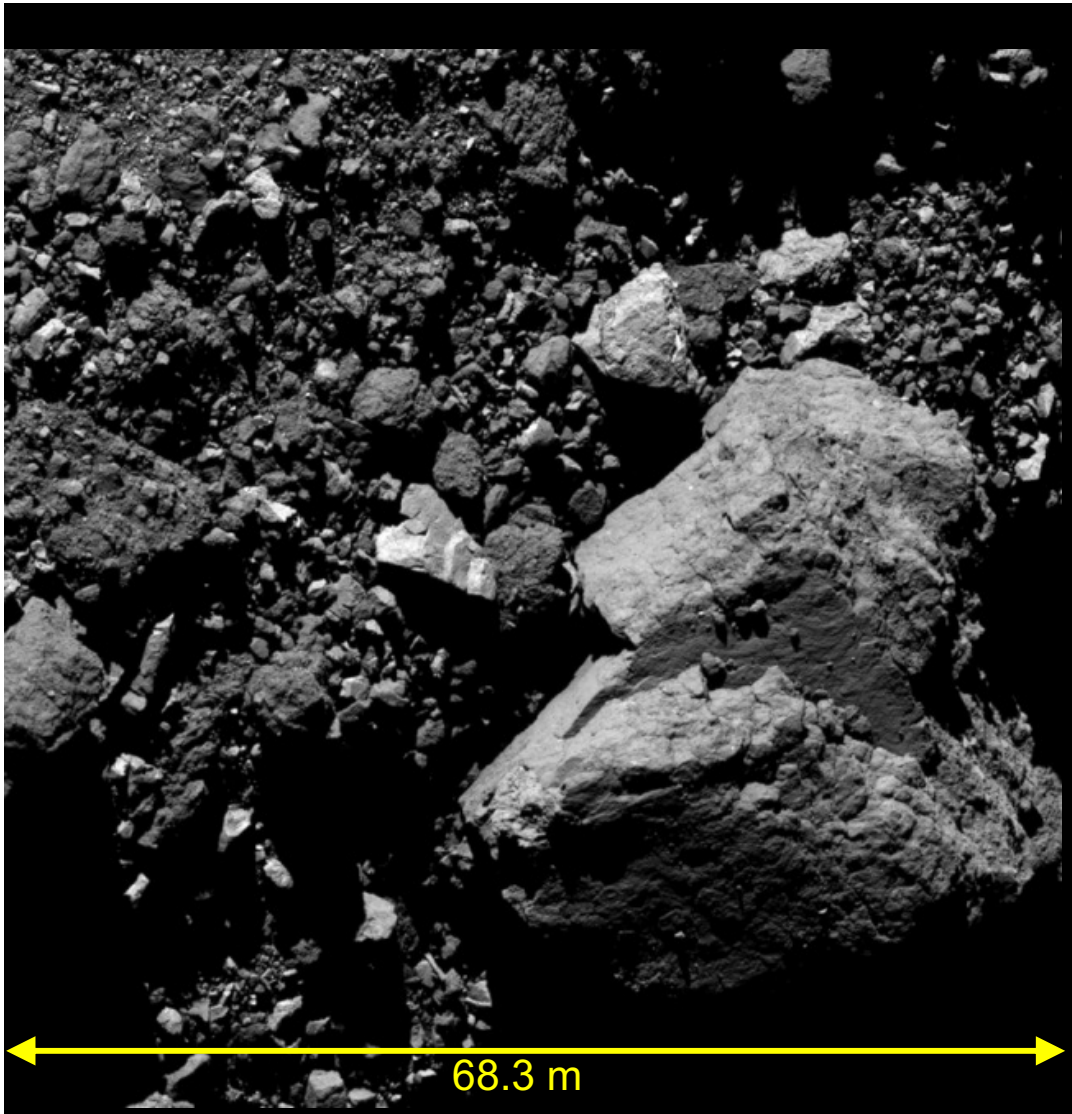
Capillary Electrophoresis-Mass Spectrometry (CE-MS)
Desorption Electrospray Ionization-Mass spectrometry (DESI-MS)
Elemental Analysis-Isotopic Ratio Mass Spectrometry (EA-IRMS)
Fourier Transform Ion Cyclotron Resonance Mass Spectrometry (FTICR-MS)
Gas Chromatography-Mass Spectrometry (GC-MS)
Gas Chromatography–Fourier Transform-Isotopic Ratio Mass Spectrometry (GC-FTMS)
Gas Chromatography–Combustion-Isotopic Ratio Mass Spectrometry (GC-IRMS)
Ion Chromatography (IC)
Ion Chromatography-Mass Spectrometry (IC-MS)
Keyence digital stereo microscopy
Liquid Chromatography-Mass Spectrometry (LC-MS)
Microprobe Two Step Laser Mass Spectrometry (μL^2MS)
Microscale Fourier Transform Infrared Spectroscopy (μ-FTIR)
Nanoscale Fourier Transform Infrared Spectroscopy (nano-FTIR)
Nanoscale secondary ion mass spectrometry (nanoSIMS)
Nuclear Magnetic Resonance Spectroscopy (NMR)
Pyrolysis-Gas Chromatography-Mass Spectrometry (pyGC-MS)
Raman Vibrational Spectroscopy
Scanning Electron Microscopy/Energy-Dispersive X-ray Spectroscopy (SEM/EDS)
Solid-State Nuclear Magnetic Resonance Spectroscopy (SS-NMR)
Thermal Desorption/Pyrolysis-Gas Chromatography-Mass Spectrometry (TD/pyGC-MS)
Two-dimensional Gas Chromatography-Mass Spectrometry (GC×GC-MS)
X-ray Absorption Near-Edge Structure Spectroscopy (XANES)

What is the Bennu sample like?

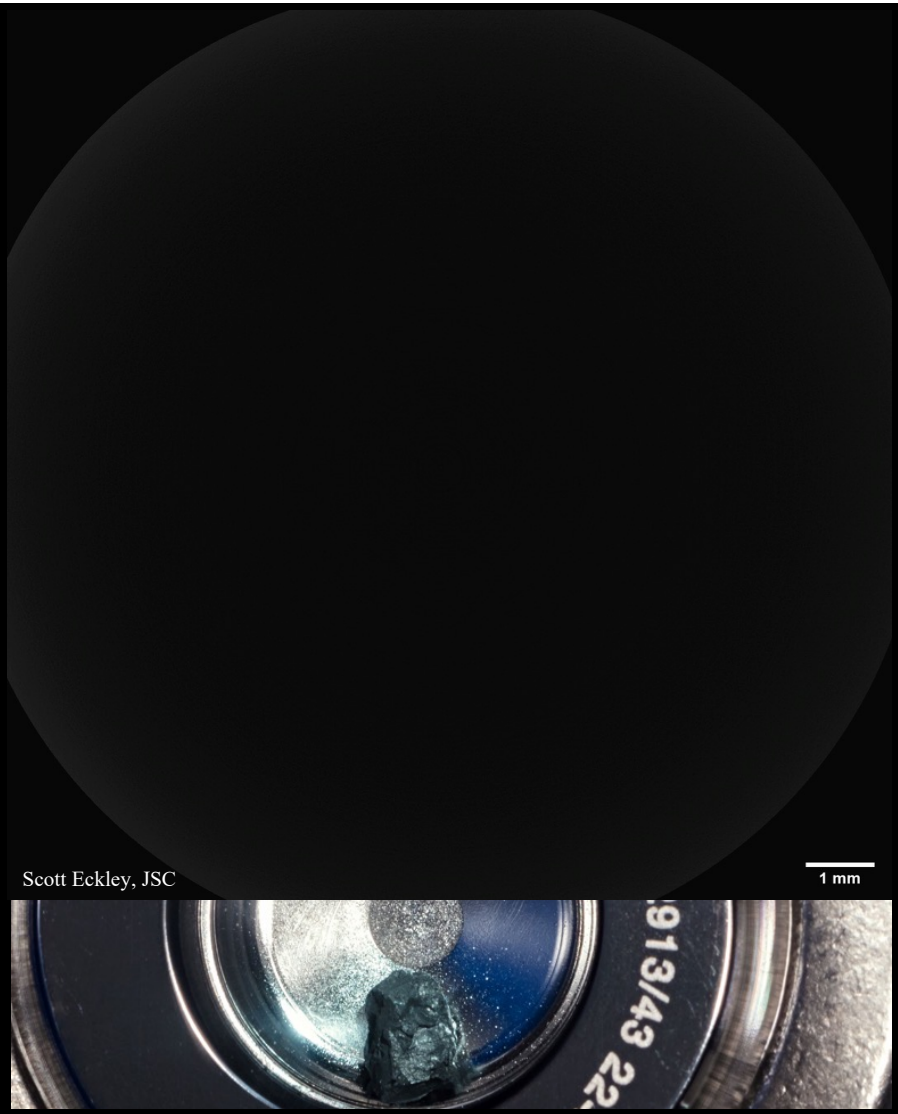
- Smell is very strong (sulfur, gun-powder and burned marshmallows)
- Dark black with some lighter/white particles throughout and shimmery particles (different lighting changes appearance)
- Very fine powders that stick to everything and are very challenging to remove from surfaces
- Some pieces are very angular, and some are very hummocky
- Density varies

Rachel Funk, JSC



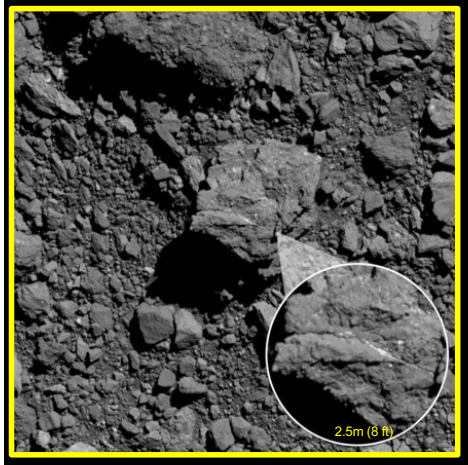


Flight Imagery



Smithsonian National Museum of Natural History

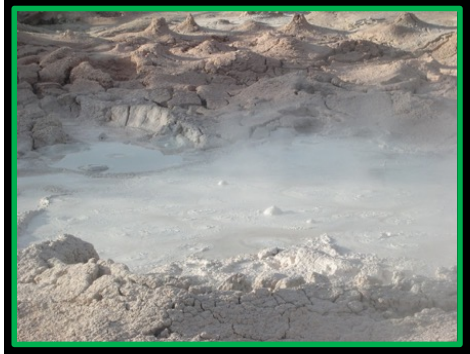
Sample Science

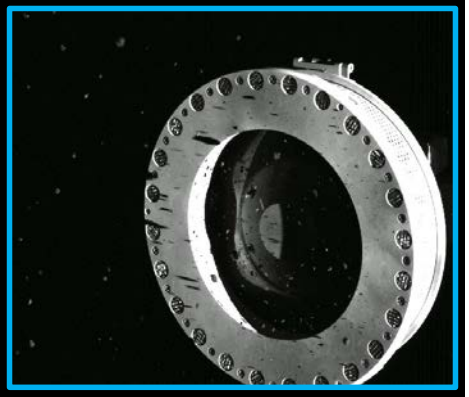


Flight Imagery

1. How does the sample compare with observations from the spacecraft at Bennu?
2. Does the sample contain organic compounds that could have influenced the origin of life?
3-11. What does the sample tell us about the history of the solar system?
12. How has the sample changed since collection?

JWST Imagery


Fumarole, Yellowstone NP


Flight Imagery

1. How does the sample compare with observations from the spacecraft at Bennu?

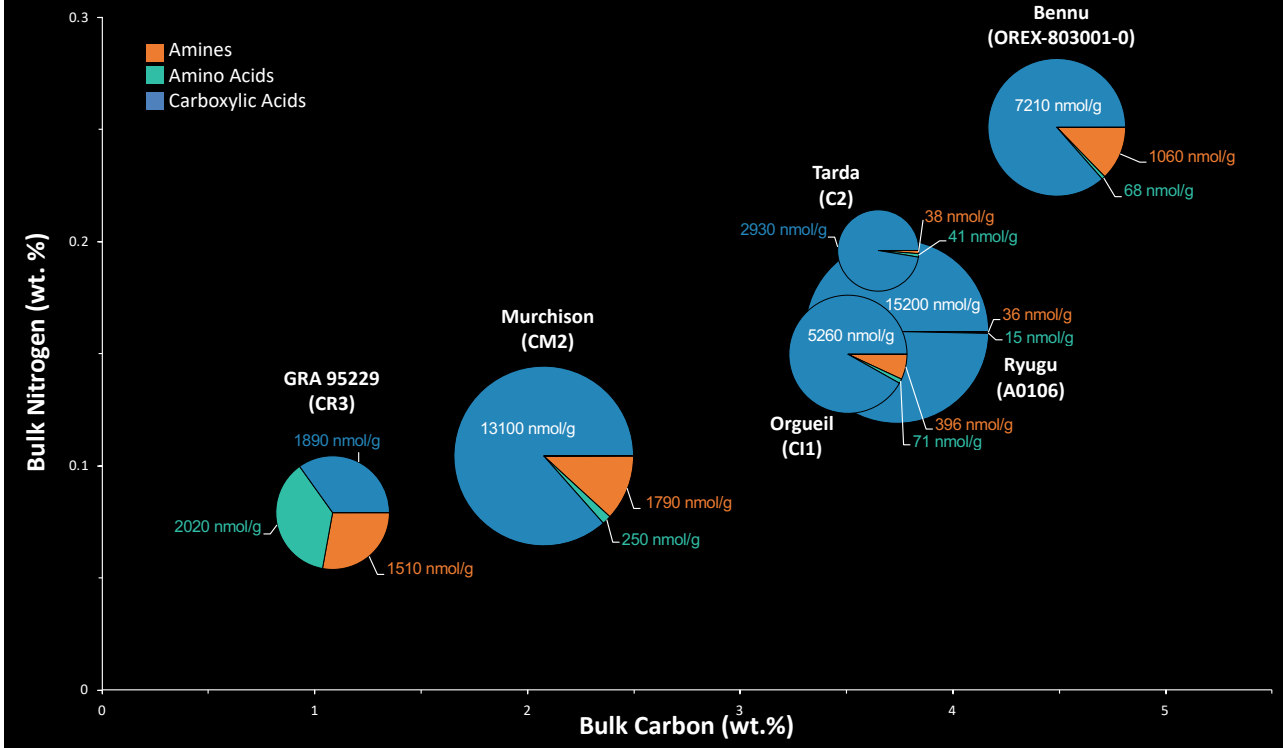
Observed at Bennu:

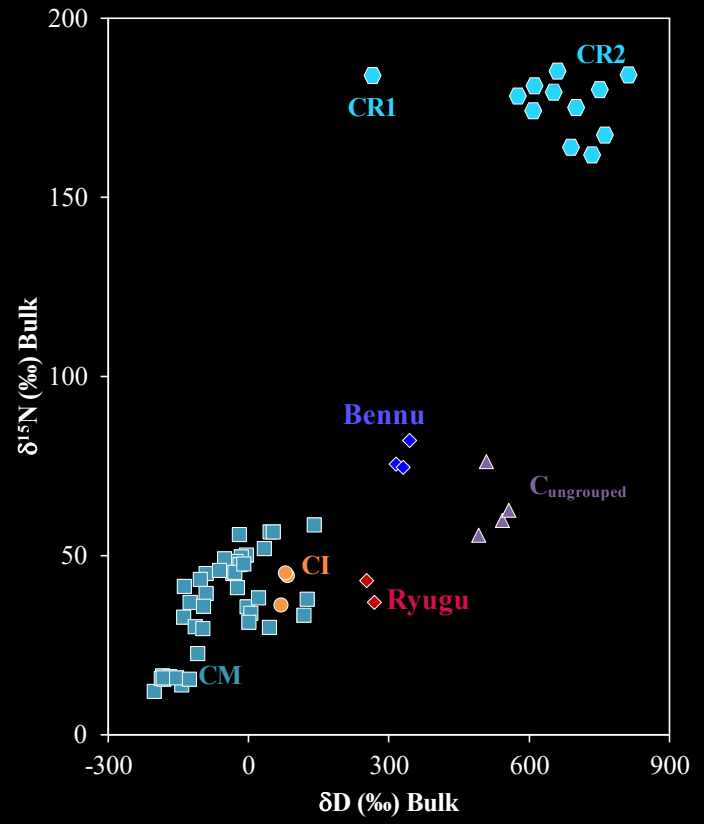
- Phyllosilicates
- Iron sulfides
- Magnetite
- Carbonates
- Hydrated, >1% C
- Xenoliths
- Phosphates

0.8-0.9%	H	
4.5-4.7%	C	by EA-IRMS
0.25%	N	

Lauretta, et al. (2024) *Met Planet Sci* 10.1111/maps.14227

2. Does the sample contain organic compounds that could have influenced the origin of life?





Dworkin et al. AbSciCon 2024

Lauretta, et al. (2024) *Met Planet Sci* 10.1111/maps.14227

3-11. What does the sample tell us about the history of the solar system? Recent History

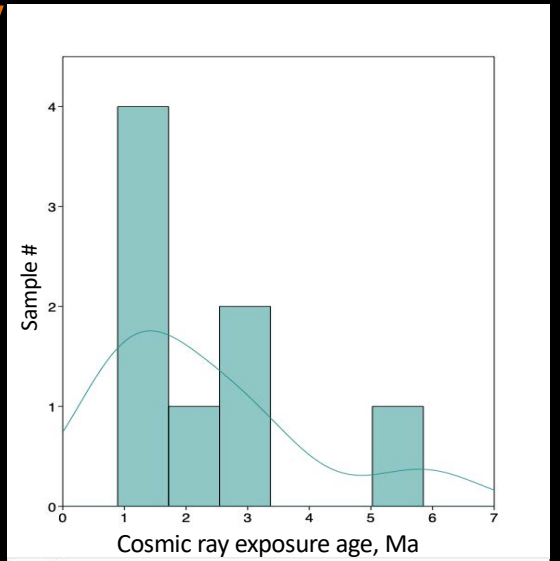
Sample on Bennu's surface for 1-6 Ma

The ^{21}Ne cosmic ray exposure age is 1-6 Ma, consistent with Bennu dynamically decoupled from the main asteroid belt for 1.75 ± 0.75 million years

Neon and Xenon originate from before the solar system formed

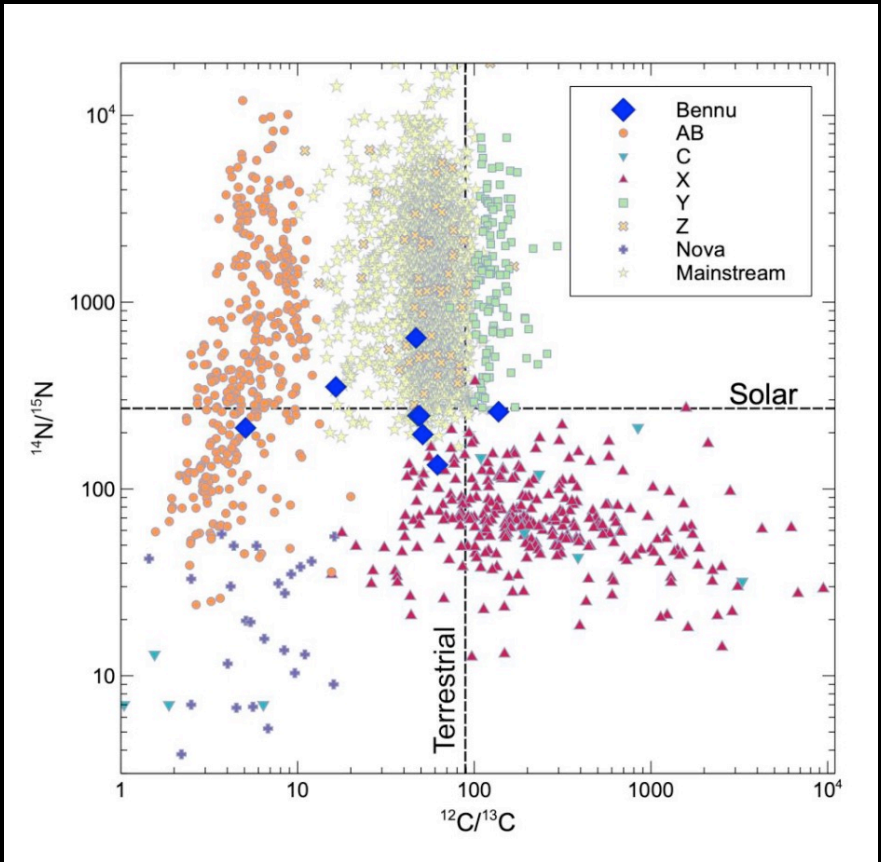
Neon is a mixture of Q-phase (seen in meteorites), solar wind, and presolar noble gases.

Xenon is enriched in presolar isotopes.



Marty et al. LPSC 2024

3-11. What does the sample tell us about the history of the solar system? Ancient History



Presolar SiC and graphite grains predate the solar system

Presolar grains derive from evolved stars and make up some of the building blocks of the solar system

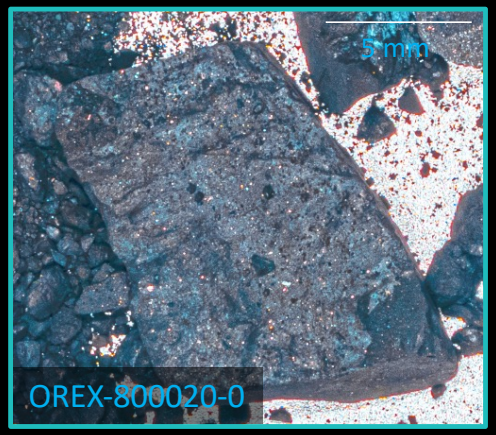
The isotopic compositions of the presolar SiC indicate diverse stellar sources, including supernova

The abundances of these grains are similar to those in unheated chondrite meteorites

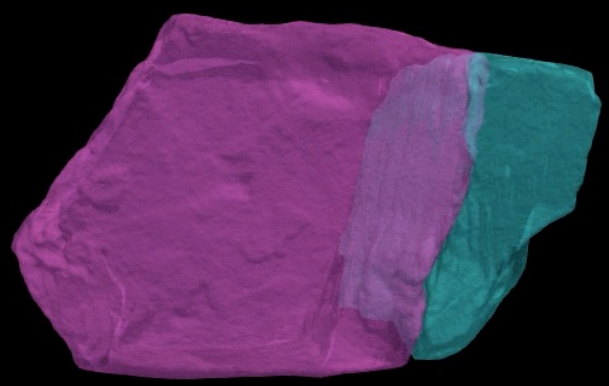
Lauretta, et al. (2024) *Met Planet Sci* 10.1111/maps.14227

12. How has the sample changed since collection?

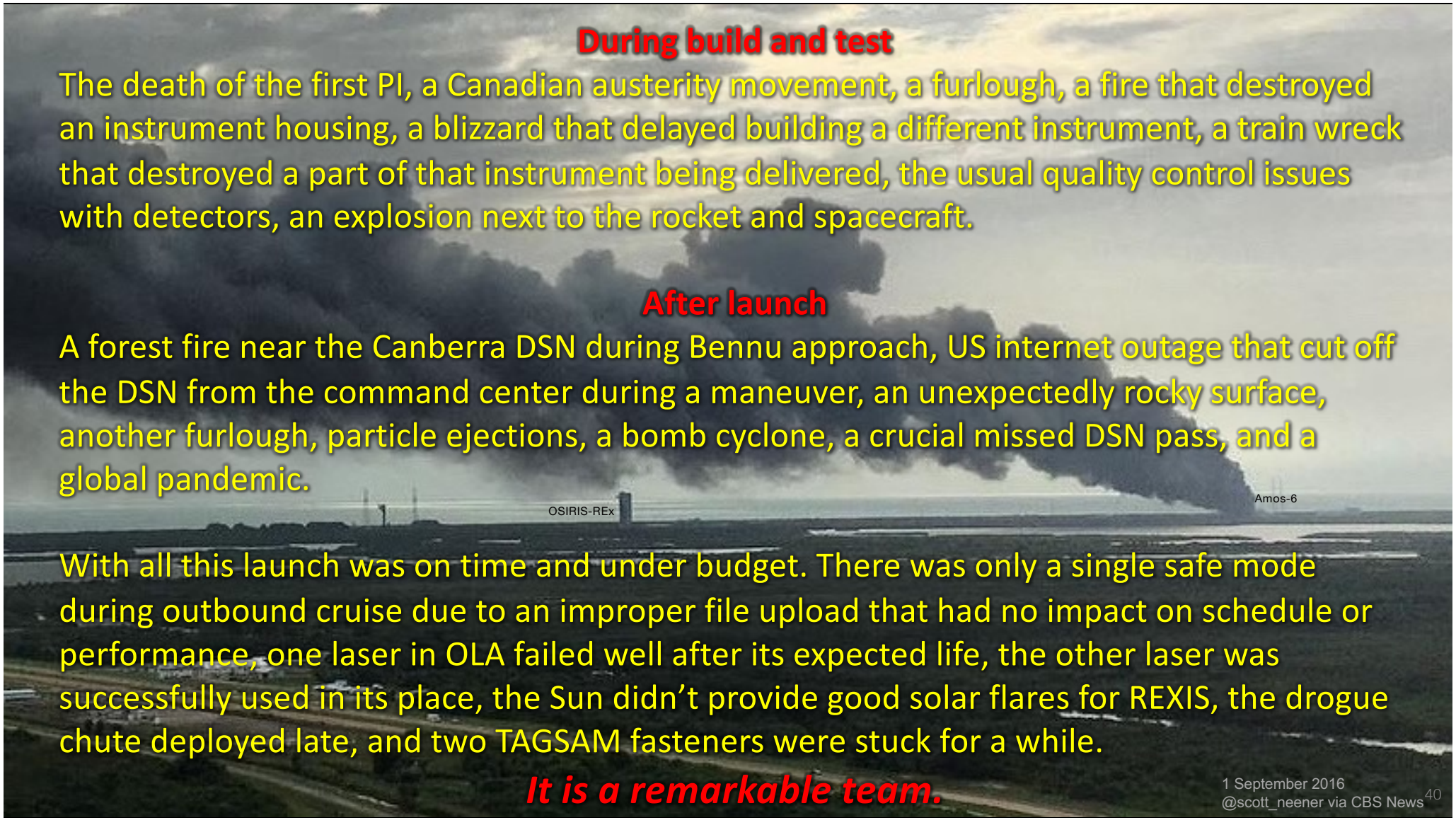
Two of the larger stones in the sample fit together like puzzle pieces.



Shape models of OREX-800017-0 and OREX-800020-0 from Structured-Light Scanning



The face of OREX-800020-0 shown in the above AIVA image is the fracture plane (NASA/JSC/ARES).



During build and test

The death of the first PI, a Canadian austerity movement, a furlough, a fire that destroyed an instrument housing, a blizzard that delayed building a different instrument, a train wreck that destroyed a part of that instrument being delivered, the usual quality control issues with detectors, an explosion next to the rocket and spacecraft.

After launch

A forest fire near the Canberra DSN during Bennu approach, US internet outage that cut off the DSN from the command center during a maneuver, an unexpectedly rocky surface, another furlough, particle ejections, a bomb cyclone, a crucial missed DSN pass, and a global pandemic.

With all this launch was on time and under budget. There was only a single safe mode during outbound cruise due to an improper file upload that had no impact on schedule or performance, one laser in OLA failed well after its expected life, the other laser was successfully used in its place, the Sun didn't provide good solar flares for REXIS, the drogue chute deployed late, and two TAGSAM fasteners were stuck for a while.

It is a remarkable team.

1 September 2016
@scott_neener via CBS News

NASA.gov/OSIRIS-REx

NASASolarSystem

AsteroidMission.org

NASASolarSystem

NASASolarSystem

Sample Catalogue

This material is based upon work supported by NASA under Award NNH09ZDA007O and Contract NNM10AA11C issued through the New Frontiers Program.

We are grateful to the entire OSIRIS-REx Team for making the return of samples from asteroid Bennu possible.

Public Comments

Email nathan.j.boll@nasa.gov
by October 10, 2024 at 11:30am EST

National Aeronautics and Space Administration

NAC Science Committee: Outbrief to SMD

Amanda Hendrix, Chair

Sandra Connelly, SMD Deputy Associate Administrator

Doug Hudgins, SMD Assistant Deputy Associate Administrator for Research (Acting)

SMD update

- Kudos to NASA SMD for disaster coordination work, actively using NASA data and working with other agencies (e.g. EPA) to make data available and usable
    - It is great that NASA data are being integrated into hazard/disaster mitigation programs/efforts
- In future SC meetings, the Committee would welcome a discussion - as a topic in the AA briefing - from the AA on the agenda topics and her thoughts on how the SC can support SMD in the areas covered on the agenda (and any other areas).
- DACs: The SC notes inconsistencies in the way the different DACs are operating - and particularly the frequency/cadence at which they meet (related to a past SC F&R and recent NAC discussion)

IDEA Initiatives Panel

- Kudos to SMD for the useful Research and Analysis Program Yearbooks

Potential topics of F&Rs:

- NSPIRES demographic questions are largely controlled by external policies, and any change would require OMB approval.
- There is currently not a named position at SMD for IDEA-related programs.
- Victims of sexual harassment, assault, and bullying need more support to address potential instances occurring at an institution, in the field, at a conference, etc. by NASA-funded individuals.
- Undergraduate research opportunities fall through the cracks in existing SMD programs, and they are important particularly for the retention of underrepresented people.

Topics for future SC meetings:

- NAC SC looks forward to seeing SMD's response to the two NASEM reports:
  - Committee on Increasing Diversity and Inclusion in the Leadership of Competed Space Missions
  - Foundation for Assessing the Health and Vitality of the Science Mission Directorate's Research Communities

Open Science Initiatives Panel

- Kudos: Office of the Chief Science Data Officer (OCSDO) is making great strides in the Open Science community and maximizing contributions with limited resources.

Potential topics of F&Rs:

- NASA Open Science collaborate more with industry to advance science thru the TRL scale (e.g., vertical LLM agents).

Topics for future SC meetings:

- OCSDO: update NAC SC at the next meeting on its Tiger Team status.
- OCSDO update NAC SC at the next meeting on what they are doing to improve quality of searches, collaboration, barriers to entry.
  - Equity in Open Science initiative is an area of concern
- Next NAC SC meeting: NASA AI, SBIR, Tech Directorate POCs to discuss art of the possible to build new products to capitalize on data for more collaborations.

Climate Change Panel

Potential F&Rs (a sampling):

There is a perception among the broader world that climate change is not a priority at NASA, and the observations being made are not enough.

- NASA should define and prioritize the intended outcomes of the NASA climate strategy (what will NASA have contributed if successful to climate change mitigation and resilience);
- NASA's niche/role as complemented by others in achieving the Administration's climate goals (mitigation and resilience);
- Metrics to assuring adherence to path to success in making a significant impact on climate change mitigation and resilience

Space Weather Panel

Kudos: Great work with the Heliophysics Big Year and good job with cross-cutting work across agencies, especially with limited resources.

Potential F&R (sampling):

- Awareness and understanding of the importance of Heliophysics should be improved.
- As discussed, there a number of challenges in terms of science to be done and measurements to be made.
- There is a risk of no real space monitors past L1, L3.
- Maintain the momentum of the Heliophysics Big Year.
- Expand assessment economic impact of these space weather events, including partnerships.

R&A

Potential F&R:

- R&A is very important, and yet there is significant proposal pressure in many/all divisions
- It's unclear what percentage of R&A is of SMD Division budgets, including selection rates.
- FINESST for Astrophysics is incredibly successful program. However, the program is not reaching a significant fraction of the astronomical community and there are significant barriers to applicants.

Topics for future SC meetings:

- At the next NAC Science Committee, each DAC present each's Divisions' R&A budget, including percentage of overall budget, rationale to maximize transparency and clarification.

VIPER

Potential F&R:

- The cancellation of the VIPER mission presents profound impacts on the understanding of lunar volatiles, a key foundation of the Artemis program, and it adversely affects the leadership of the US in lunar exploration.
- It is important that these instruments stay competitive for lunar science, and preferably to keep rover intact
- It is hoped that no irreversible action will be taken before the science community can weigh in

Topic for next SC meeting:

- NASA update NAC SC at the next meeting on the forward strategy for VIPER pending RFI results.

Mission budgets, cancellations and extensions

Potential F&R:

- Cancelling missions (e.g., GDC) impacts the broader space community. Extending missions must be balanced on new missions.
- In a constrained budget environment, transparent decisions on cancelling or extending missions should be more clear, as well as understanding science value versus cost.

Topic for next SC meeting:

- How does SMD get independent evaluations of technical readiness and cost & schedule for flagship missions? What's the process?
- How to balance cost-overruns on big missions (say Discovery/Midex/NewFrontiers/Flagship) vs. R&A budgets? Is this something the NAC and/or Sci Comm and/or DACs should be involved in?

ISS

Potential F&R:

- ISS is a worldwide asset and key to space and science research as a national laboratory.
- Biological and physical sciences relies on a space station platform, government or commercial, and will be impacted by gaps or potential transitions or throttling back of capabilities.
    - Transition of capabilities to commercial LEO destinations/national lab concepts, space diplomacy, also requirements & communication thereof, is a concern

Topic for next SC meeting:

- NAC SC requests a briefing on ISS transition to Commercial LEO Destinations (CLD)

Other potential F&Rs

MSR

- MSR's role in National Posture and potential for funding beyond current NASA budget

Planetary "preservation"

- i.e. concerns about scientific integrity beyond the strict definition of planetary protection

HEC availability and accessibility

- What the needs are and how addressed (not just at ESAC level)

ANSMET

- The need for logistical support to reinstate and continue this important program

DSN update (a priority for many divisions)

- In light of the recently-released NASEM Crossroads report, the NAC SC reiterates the prior findings re: DSN
- DSN funding and strategies should be prioritized. Best practices on DSN should be communicated and balanced with usage plans.

Finally….

Topics for next SC meeting:

- A briefing on the ESD decadal midterm review would be welcome at the next SC meeting
- Briefing from Norm Augustine on the Crossroads report,
- Briefing from SMD on what SMD's response is (out of cycle, if needed, for timely information before irreversible decisons are made)

Meeting Adjourned

Meeting documentation will be available at
https://science.nasa.gov/science-committee