NAC SCIENCE COMMITTEE SPRING MEETING

March 25, 2024



Designated Federal Official (DFO) Introduction

Nathan Boll

Executive Secretary



NAC Science Committee

Dr. Ellen Williams, Chair

March 25, 2024





NAC Science Committee Members Introductions

Ellen Williams (Chair), University of Maryland

Noël Bakhtian, Bezos Earth Fund

Paul Cassak, West Virginia University
Chair, Heliophysics Advisory Committee (HPAC)

Jamie Foster, University of Florida
Chair, Biological and Physical Sciences Advisory Committee (BPAC)

Linda M. Godwin, University of Missouri

Kelly Holley-Bockelmann, Vanderbilt University
Chair, Astrophysics Advisory Committee (APAC)

Hope Ishii, University of Hawai‘i at Mānoa
Chair, Planetary Science Advisory Committee (PAC)

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

Executive Secretary: Nathan Boll, NASA Headquarters

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



Outgoing Science Committee Members

- Vinton Cerf, Google
- Serina Diniega, Jet Propulsion Laboratory
- Willie E. May, Morgan State University
- Marc Weiser, RPM Ventures

Outgoing Executive Secretary

- Jason Callahan, NASA Headquarters

NAC Science Committee
2023 Findings and Recommendations

1. Resolutions
2. Science Mission Directorate
3. DAC Reports – Spring Meeting
4. DAC Reports – Summer Meeting
5. Earth Science Observatory IRB Report
6. Tropospheric Emissions: Monitoring Pollution (TEMPO) Mission
7. Deep Space Network (DSN)
8. Transform to Open Science (TOPS) Program
9. Inclusion, Diversity, Equity, and Accessibility (IDEA) at SMD

NAC Science Committee Agenda
Monday, March 25, 2024

• 10:00-10:05	Call to Order	Nathan Boll, Executive Secretary
• 10:05-10:15	Introduction of Members/Summary of Agenda	Ellen Williams, Chair
• 10:15-11:15	SMD Update and Budget Presentation	Nicky Fox, SMD AA
• *11:15-12:45pm*	*Break (90 min)*	
• 12:45-2:15	Division Advisory Committee (DAC) Chair Reports	Kelly Holley-Bockelman, APAC Jamie Foster, BPAC Sara Tucker, ESAC Paul Cassak, HPAC Hope Ishii, PAC
• 2:15-2:30	Public Comments	
• *2:30-2:45*	*Break (15 min)*	
• 2:45-4:15	Committee Discussion	
• *4:15-4:30*	*Break (15 min)*	
• 4:30-5:00	Briefing to NASA SMD AA, Nicky Fox	Ellen Williams, Chair
• *5:00*	*Adjourn*	



Dr. Nicola “Nicky” Fox

Associate Administrator
Science Mission Directorate

- Formerly served as the Director of the SMD Heliophysics Division
- Formerly served as the Chief Scientist for heliophysics at the Johns Hopkins University Applied Physics Lab
- Awarded the NASA Outstanding Leadership Medal and the American Astronautical Society’s Carl Sagan Memorial Award for her demonstrated leadership in the field of heliophysics
- Holds a Ph.D. in Space and Atmospheric Physics from The Imperial College of Science, Technology and Medicine in London
- Extensive background in heliophysics and space weather research



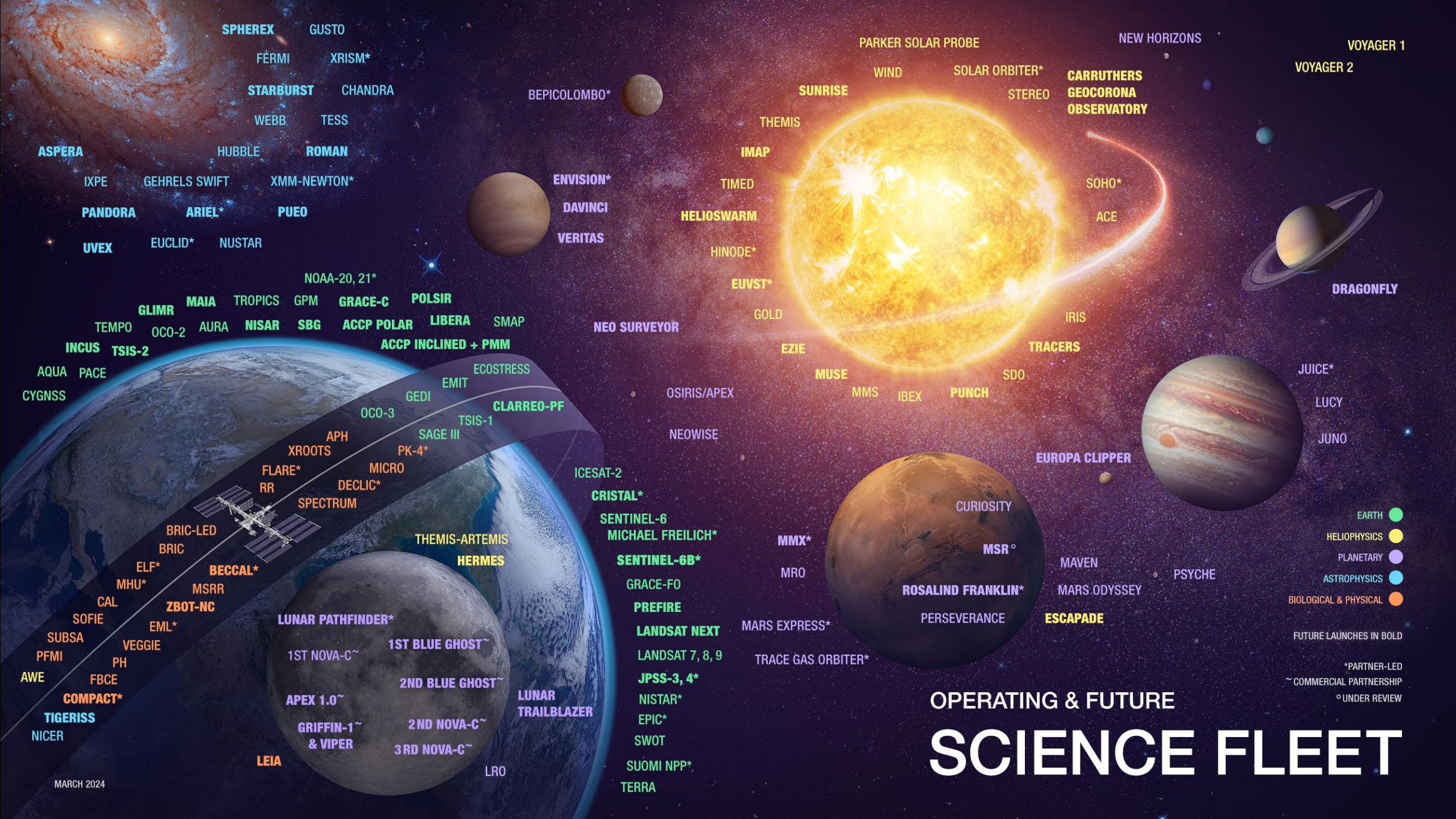
National Aeronautics and Space Administration

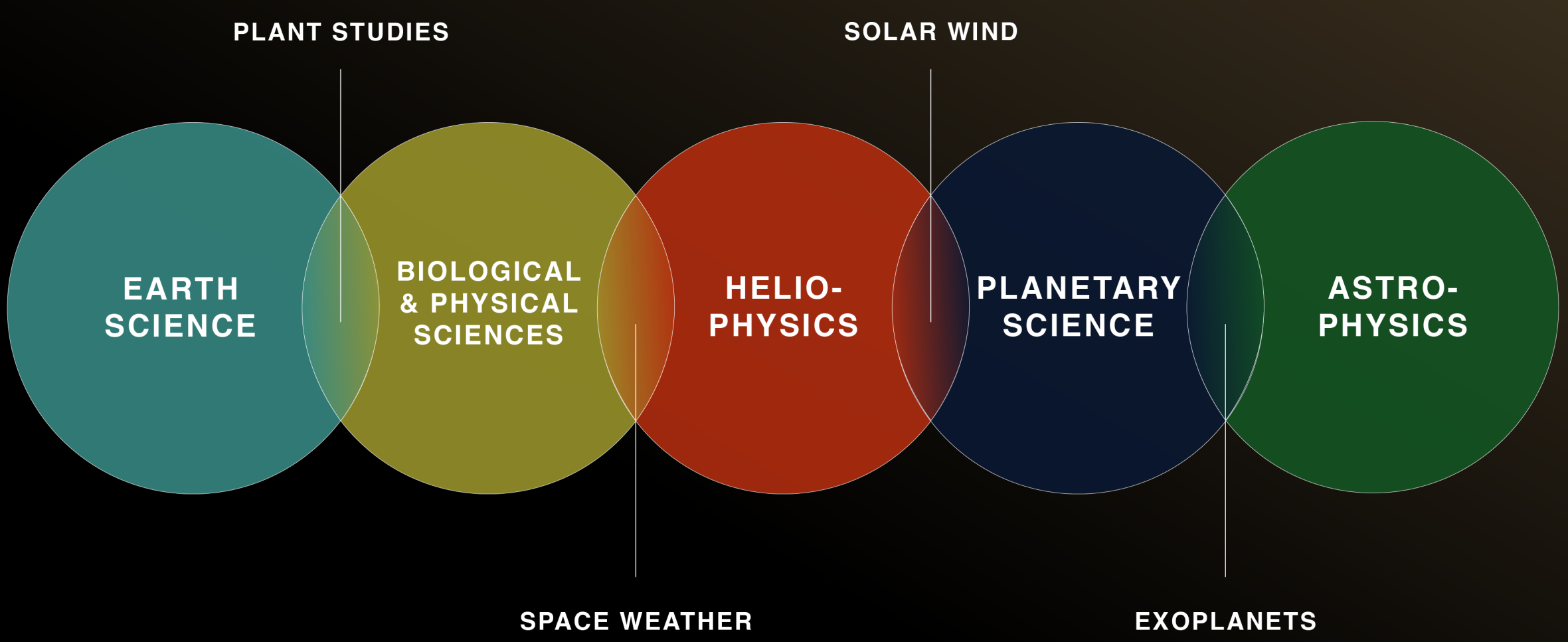
NASA'S Vision for Powerful Science

Dr. Nicola Fox
Associate Administrator
NASA Science Mission Directorate
@NASAScienceAA



Thank you, Ellen!


SPHEREX
GUSTO
FERMI
XRISM*
STARBURST
CHANDRA
WEBB
TESS
ASPERA
HUBBLE
ROMAN
IXPE
GEHRELS SWIFT
XMM-NEWTON*
PANDORA
ARIEL*
PUEO
UVEX
EUCLID*
NUSTAR
BEPICOLOMBO*
ENVISION*
DAVINCI
VERITAS
PARKER SOLAR PROBE
NEW HORIZONS
VOYAGER 1
VOYAGER 2
WIND
SOLAR ORBITER*
CARRUTHERS GEOCORONA OBSERVATORY
SUNRISE
STEREO
THEMIS
IMAP
TIMED
HELIOSWARM
HINODE*
EUVST*
SOHO*
ACE
DRAGONFLY
NOAA-20, 21*
GLIMR
MAIA
TROPICS
GPM
GRACE-C
POLSIR
TEMPO
OCO-2
AURA
NISAR
SBG
ACCP POLAR
LIBERA
SMAP
NEO SURVEYOR
GOLD
IRIS
INCUS
TSIS-2
ACCP INCLINED + PMM
EZIE
TRACERS
AQUA
PACE
ECOSTRESS
EMIT
MUSE
SDO
JUICE*
CYGNSS
GEDI
OSIRIS/APEX
MMS
IBEX
PUNCH
LUCY
OCO-3
CLARREO-PF
TSIS-1
JUNO
APH
SAGE III
NEOWISE
XROOTS
PK-4*
EUROPA CLIPPER
FLARE*
MICRO
ICESAT-2
RR
DECLIC*
CRISTAL*
SPECTRUM
CURIOSITY
SENTINEL-6
MICHAEL FREILICH*
BRIC-LED
THEMIS-ARTEMIS
MMX*
MSR°
BRIC
HERMES
SENTINEL-6B*
MAVEN
ELF*
BECCAL*
MRO
PSYCHE
GRACE-FO
MHU*
MSRR
ROSALIND FRANKLIN*
CAL
ZBOT-NC
PREFIRE
MARS ODYSSEY
SOFIE
LUNAR PATHFINDER*
LANDSAT NEXT
PERSEVERANCE
ESCAPADE
EML*
SUBSA
1ST BLUE GHOST~
LANDSAT 7, 8, 9
MARS EXPRESS*
VEGGIE
1ST NOVA-C~
PFMI
PH
JPSS-3, 4*
TRACE GAS ORBITER*
2ND BLUE GHOST~
AWE
FBCE
APEX 1.0~
NISTAR*
LUNAR TRAILBLAZER
COMPACT*
EPIC*
GRIFFIN-1~ & VIPER
2ND NOVA-C~
TIGERISS
SWOT
3RD NOVA-C~
NICER
LEIA
SUOMI NPP*
LRO
TERRA
MARCH 2024
EARTH
HELIOPHYSICS
PLANETARY
ASTROPHYSICS
BIOLOGICAL & PHYSICAL
FUTURE LAUNCHES IN BOLD
*PARTNER-LED
~ COMMERCIAL PARTNERSHIP
° UNDER REVIEW
OPERATING & FUTURE
SCIENCE FLEET


PLANT STUDIES
SOLAR WIND
EARTH SCIENCE
BIOLOGICAL & PHYSICAL SCIENCES
HELIO-PHYSICS
PLANETARY SCIENCE
ASTRO-PHYSICS
SPACE WEATHER
EXOPLANETS

FY25 Science Budget Priorities

The FY25 President's Budget Request for Science emphasizes a balanced approach to achieving the vision and mission of SMD within the overall constraints of the NASA budget.



Exploration and scientific discovery

IMAGE: JWST



Innovation

IMAGE: OSIRIS-REX



Interconnectivity and Partnerships

IMAGE: IM-1



Inspiration

IMAGE: 2017 SOLAR ECLIPSE

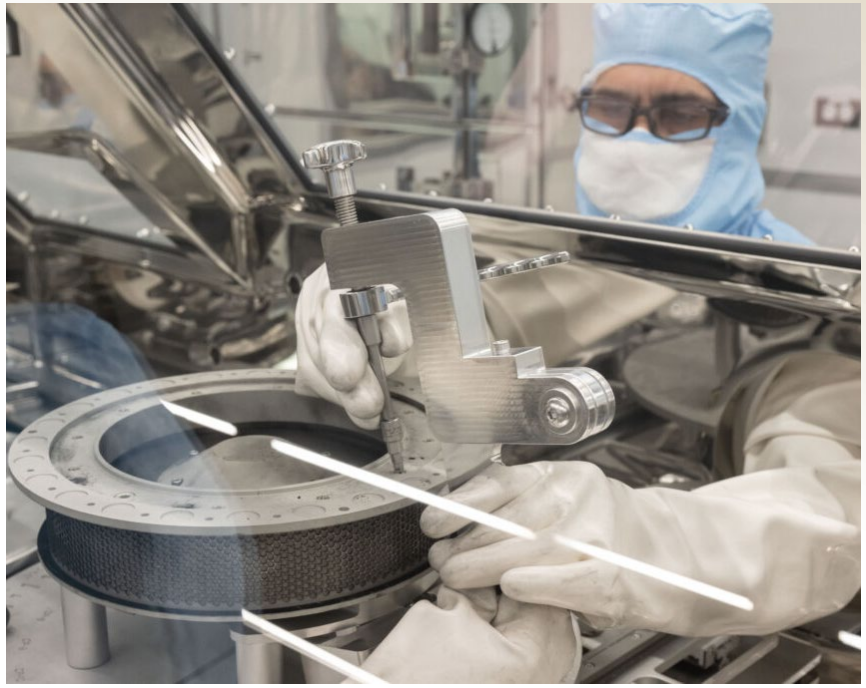


FY25 BUDGET HIGHLIGHTS

Exploration & Scientific Discovery

- A balance of legacy operating missions and investments in new technologies and missions
- Future PI-led missions within each Division
- VERITAS mission
- Lead Artemis science
- Support fundamental research

CAPTION – James Webb Space Telescope: a Massive Cluster is Born (N79)

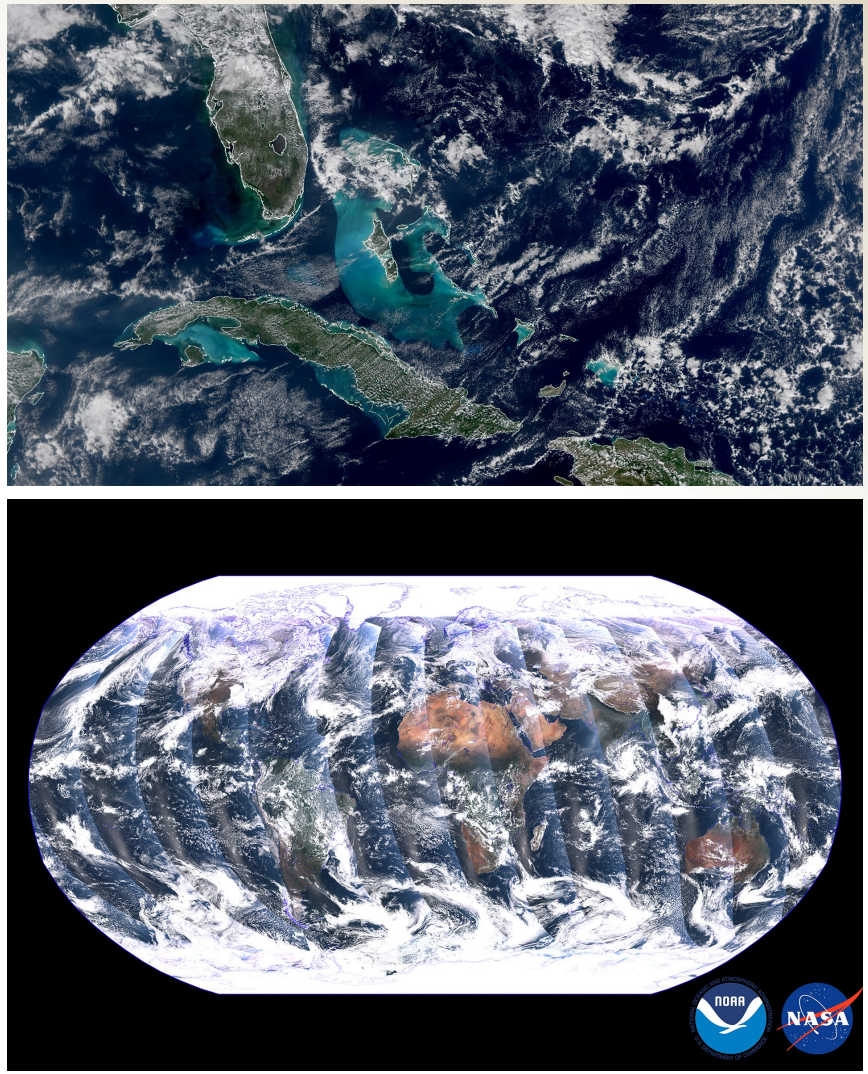


FY25 BUDGET HIGHLIGHTS

Innovation

- Mars technology development
- First space-borne gravity gradiometer
- Habitable Worlds Technology Maturation project
- Novel magnetometers
- Commercially Enabled Rapid Space Science (CERISS)

CAPTION – A NASA OSIRIS-REx curation engineer attaches one of the tools developed to help remove two final fasteners that prohibited complete disassembly of the TAGSAM (Touch-and-Go Sample Acquisition Mechanism) head that holds the remainder of material collected from asteroid Bennu



CAPTION – First images released from NOAA-21 VIIRS instrument

FY25 BUDGET HIGHLIGHTS

Interconnectivity & Partnerships

International:

- ExoMars Rosalind Franklin Rover mission
- EnVision
- LISA
- UltraSat
- EUVST/Solar-C
- Vigil
- JAXA PMM
- SBG-TIR (thermal infrared sensor free flyer) contribution to ASI mission

Industry: Commercial Lunar Payloads Services (CLPS)

Interagency:

- Landsat Next in partnership with USGS
- Earth Science Responsive Science Initiatives
- Advance Space Weather Research-to-Operations-to-Research capabilities in partnership with NOAA, NSF, and DoD

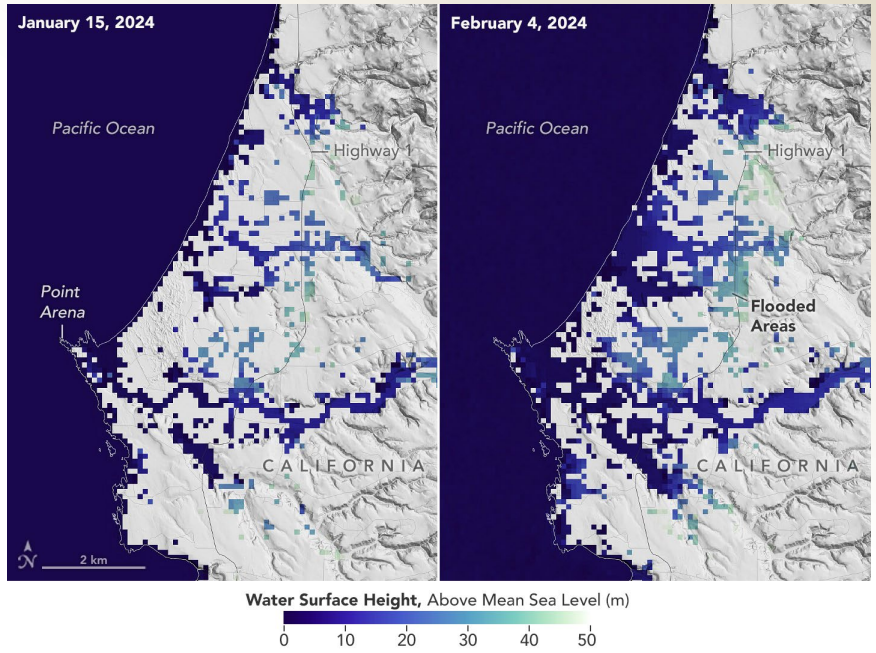


CAPTION – NASA's Student Launch Rocketry Competition 2022

FY25 BUDGET HIGHLIGHTS

Inspiration

- Science Activation Program
- Bridge Program
- FIRST Robotics
- Here to Observe
- RockOn/RockSat
- Growing Beyond Earth
- GeneLab for High School
- Student Airborne Research Program
- Open Source Science



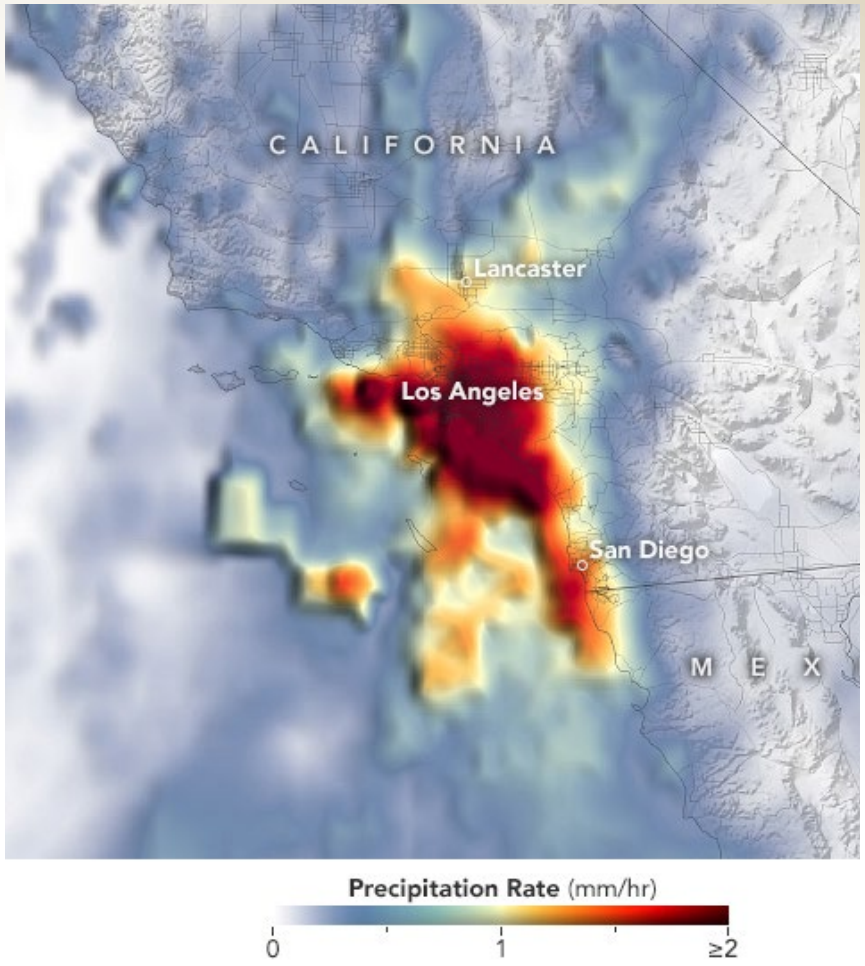
FY25 SMD Budget Changes

- MSR mission architecture is still under review; FY25 MSR budget is TBD while NASA completes internal reviews. Funding levels for Planetary Science missions are subject to change pending finalization of the path forward and proposed FY25 budget for MSR.
- Provide support for Dragonfly to uphold anticipated budget requirements for a 2028 launch to explore Saturn's moon Titan
- "Decouple, Partner, and Compete" implementation approach to the Earth System Observatory approach for the Atmosphere Observing System and Surface Biology and Geology missions
- Proposes cancellation of GDC rather than mission pause in recognition of outyear budget constraints

CAPTION – Surface Water and Ocean Topography (SWOT) Coastal Flooding Data



Science Mission Directorate
Earth Science

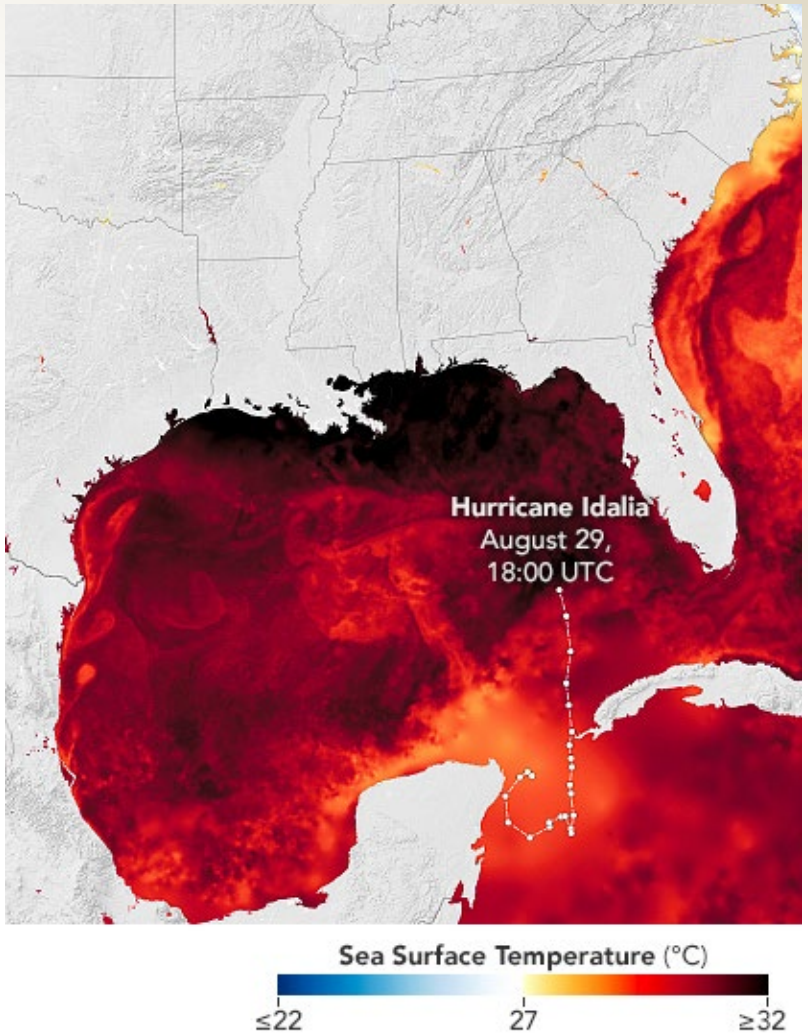


CAPTION – A potent storm drenches California on February, 5-6 2024, IMERG precipitation data as part of NASA-JAXA Global Precipitation Mission.

Earth Science Budget Highlights

- **Earth System Observatory** used a “Decouple, Partner, and Compete” approach to follow Decadal Survey recommendations and significantly reduce cost and optimize scope while remaining on track to deliver new knowledge
  - **Atmospheric Science** restructure from Atmospheric Observing System (AOS) architecture—still includes high priority observables and multiple missions; now mix of directed and at least one competed mission, with decoupled schedules
  - **Precipitation Measurement Mission** in partnership with Japan
  - **Surface Biology and Geology** directed instrument contribution to an international mission plus a mission with industry partners, with decoupled schedules
  - **Surface Deformation and Change** study discontinued, NISAR mission meets the observable

  Landsat Next proceeds to instrument procurement and supports agriculture, resource management
- **Venture & Explorer** cadence; better supports proposal development pacing



CAPTION – Hurricane Idalia track on August 29, 2023 superimposed over Multiscale Ultrahigh Resolution sea surface temperatures modeled from Terra MODIS data.

Earth Science Budget Highlights

- Extension of **Terra/Aqua/Aura** to end of life, all missions in extended operations through 2026, senior review wedge in 2027 bounds future cost growth
- Supports critical **research, applications, data and technology** for mission schedules
- Consolidation of some mission science teams and discipline research areas for greater synergies across fields
- **Responsive Science Initiatives Program** realigns elements of research, tech, applied, and data programs and will focus on areas of national importance to work with interagency partners and provide products, information, and research with significant societal value
- Includes a sustained budget increase for **Interagency Satellite Observation Needs** (formerly SNWG)
- Doubles the investment in **Geodesy** infrastructure, supporting NASA, civil space and national security needs for accurate Earth positioning
- New content in Earth Science Technology to begin developing the first space-borne **quantum gravity gradiometer (QGG)**.



Science Mission Directorate

Biological & Physical Sciences



CAPTION – NASA Artist's Illustration

BPS Budget Highlights

- Developing transformative research capabilities with commercial space industry to dramatically increase the pace of research through the **CERISS** initiative
- Optimizing BPS's budget through **partnerships**, including
  - Artemis campaign research will include science on Artemis II
  - ISS Program: Development of facility class payloads
  - International Partnerships: rideshares, facilities, joint studies
  - Other Government Agencies and ISS National Lab: Joint solicitations and studies
- Aligning with high-priority, high-visibility initiatives such as **Cancer Moonshot**
- Transformative science to address **Decadal Survey** recommendations
- Sustaining core capabilities, open science platforms, education and engagement, training programs, and inclusion, diversity, equity and accessibility (**IDEA)**

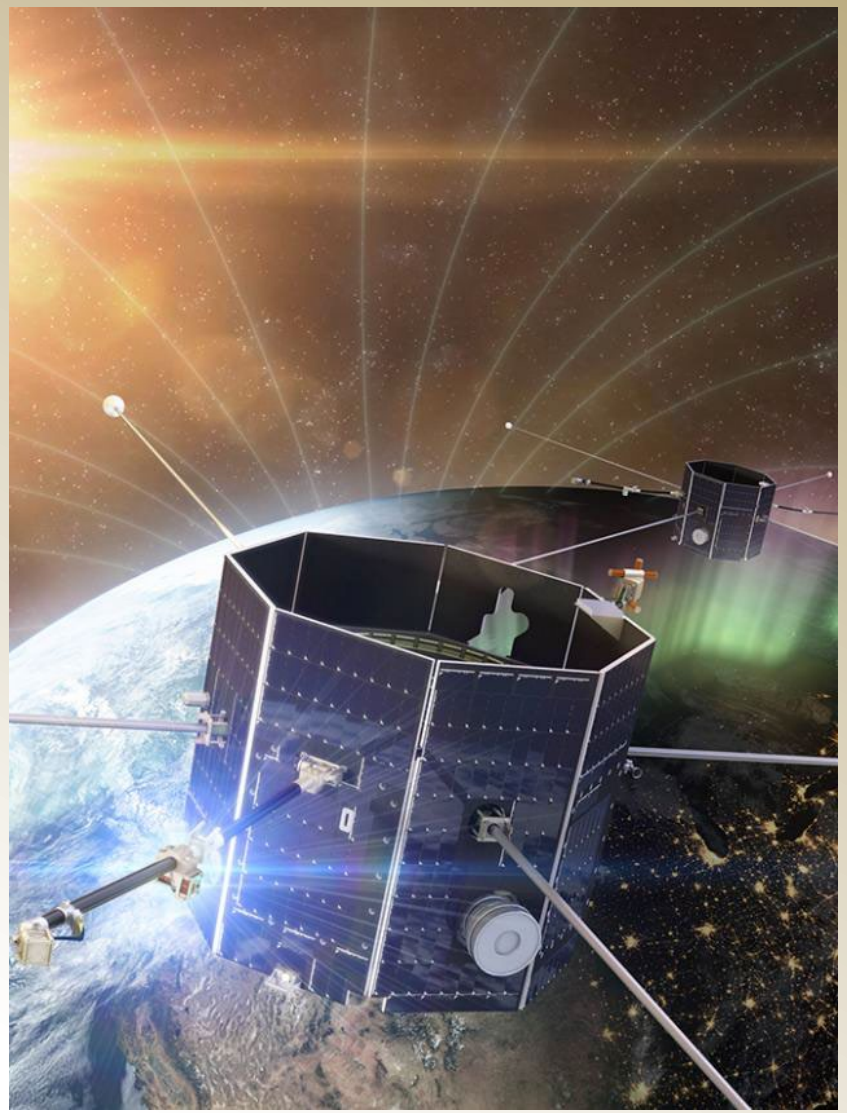


Science Mission Directorate

Heliophysics

Heliophysics Budget Highlights

- Advances **Carruthers, ESCAPADE, EZIE, IMAP, PUNCH, SunRISE,** and **TRACERS** toward launch in 2025-2026
- Supports a healthy cadence of PI-led Explorer missions
  - **MUSE** and **HelioSwarm** confirmations in 2024 and 2025
  - SMEX-22 Step 2 down-selection(s) planned for 2025
  - Future Explorer solicitations in FY25 (MIDEX) and FY28 (SMEX)
- Provides NASA contributions to **partnerships:**
  - Space Weather program includes **HERMES** instrument for **Gateway** and contribution to **ESA Vigil** mission
  - Explorers **EUVST** instrument for **JAXA Solar-C** mission
  - **CODEX** being developed through **NASA-KASI** partnership for launch to ISS
- Proposes cancellation of **GDC** rather than a 3-year pause in recognition of outyear budget constraints



CAPTION – Illustration of the TRACERS satellites in space.

Heliophysics Budget Highlights

- Supports **Space Weather** Centers of Excellence and quad-agency efforts in Research-to-Operations-to-Research (R2O2R) to advance space weather research and applications
- Provides agency capabilities in **Research Range** and **Sounding Rockets** in support of innovative small payloads
- Invests in advancement of Heliophysics technologies
- Supports demonstration of technologies for characterizing **orbital debris**
- Supports continued scientific discovery through the Heliophysics DRIVE Science Centers
- Increases funding for **CubeSats** and open science initiatives within R&A
- Improves sustainability of Heliophysics System Observatory and missions in **extended operations** consistent with recommendations from 2023 Senior Review

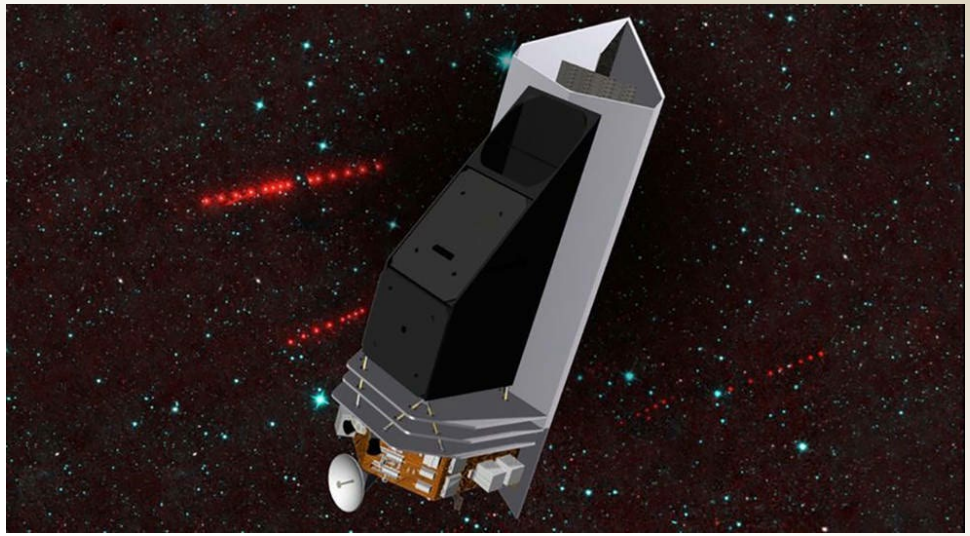


CAPTION – A sounding rocket soars skyward at Launch Complex 36 at White Sands Missile Range in New Mexico on Oct. 14 to capture data on the annular solar eclipse.

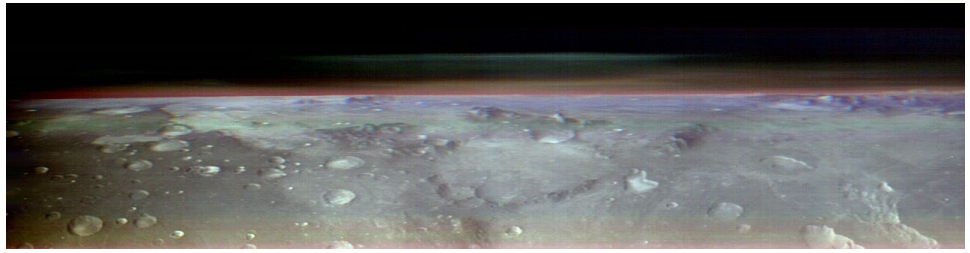
Photo Credit: U.S. Army by Judy Hawkins/Released



Science Mission Directorate
Planetary Science



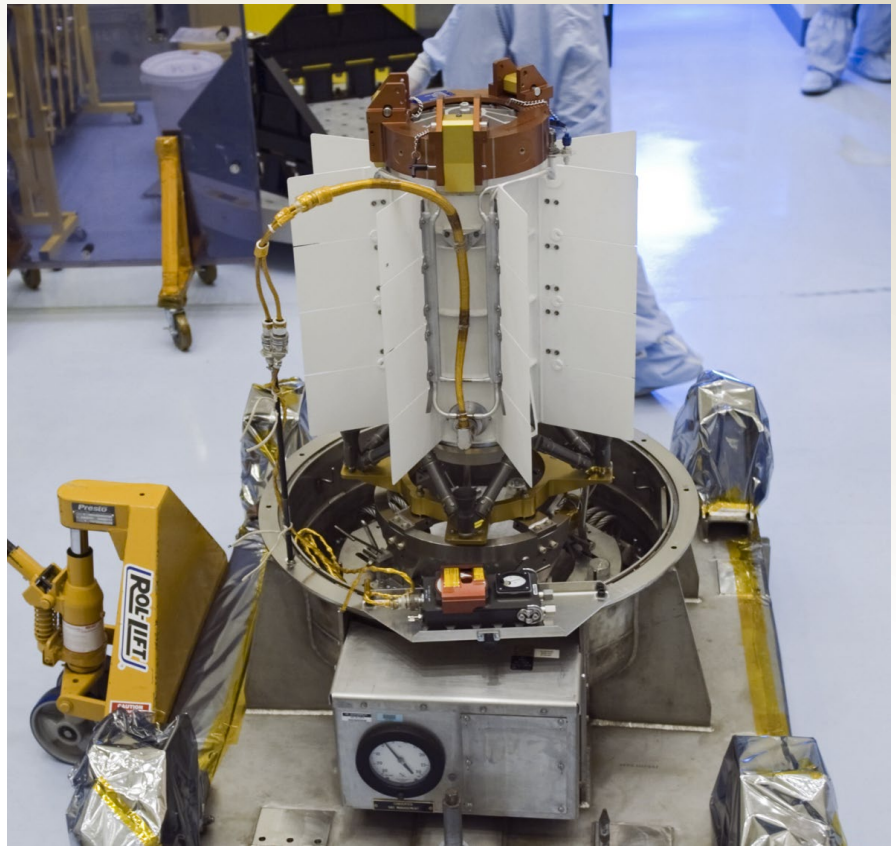
CAPTION – Artist conception of the NEO Surveyor spacecraft.
Image credit: NASA/JPL-Caltech



CAPTION – 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

Planetary Science Highlights

- **Mars Sample Return** has slowed down in FY24 while architecture studies are completed; NASA expects to provide an FY25 budget for MSR this spring
- Supports launches of **Europa Clipper** (Oct 2024) and **NEO Surveyor** (2028)
- Supports **Dragonfly** mission for 2028 LRD in anticipation of confirmation decision in 2024
- 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 for **VIPER** and **Lunar Trailblazer** for planned launches in FY 2025



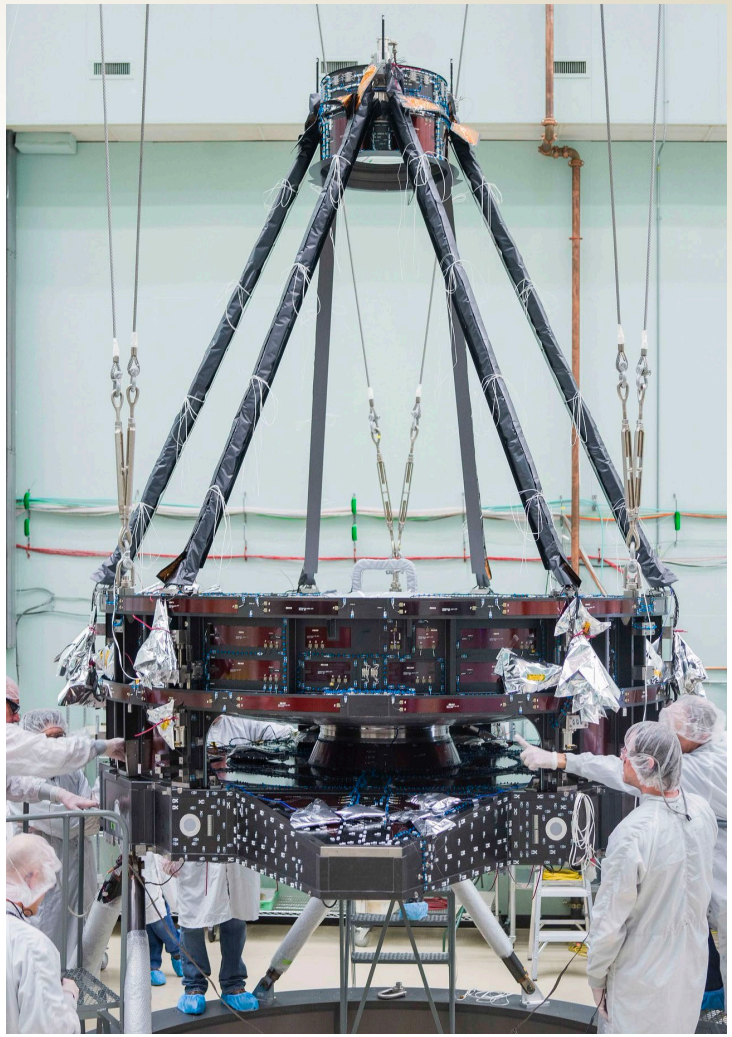
CAPTION – An RPS MMRTG. This unit is currently installed and operating on the Curiosity Rover.
Image Credit: NASA/DOE

Planetary Science Highlights

- 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

Science Mission Directorate

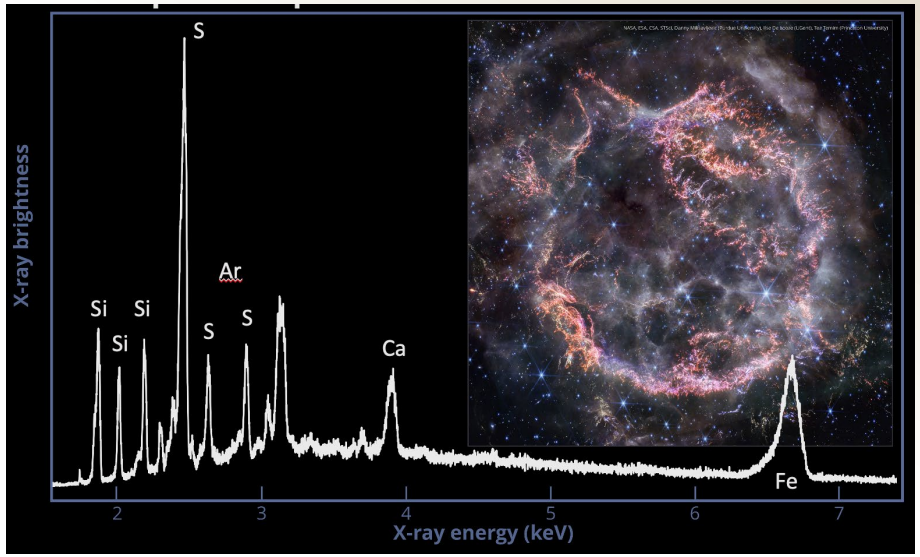
Astrophysics



CAPTION – Nancy Grace Roman Telescope assembly

Astrophysics Budget Highlights

- Nancy Grace **Roman** Space Telescope is on track for launch in 2027. NASA's first survey astrophysics flagship, each year of **Roman** observations will comprise community defined and proposer-led surveys.
- Investments in future missions:
  - **Habitable Worlds Observatory** technology maturation increase in FY25
  - First Astrophysics Probe selections planned for Q1 in FY25
  - Support a healthy cadence of **Explorer** missions
    - SPHEREx (2025) preparing for launch
    - COSI proceeding towards confirmation;
    - UVEX will begin formulation activities
    - Future AOs for SMEX (2025) and MIDEX (2027)
- Mini-Senior Review planned for **Chandra** and **Hubble** to seek community guidance on options for future science operations model.



CAPTION – XRISM (X-ray Imaging and Spectroscopy Mission), a partnership with the Japanese Space Agency (JAXA) has released a first look at the supernova remnant CAS-A. The spectrum shows elements produced in the supernova explosion and the extreme velocities of the ejected material. The image of CAS-A is a recent JWST observation.
Credit: JAXA/NASA/XRISM

Astrophysics Budget Highlights

- Operate **James Webb Space Telescope** with a robust competed science program (Webb Science)
- **Senior Review** funding allocated to remaining APD missions recommended for continued operations until next Senior Review in 2026
- **Balloon** program funding for new North American launch site and foreign campaigns

  SOFIA funding to complete shutdown with aircraft parts disposition in FY25
- **R&A** funding to maintain healthy selection rates as well as workforce development and early career faculty awards
- **Technology** investments in SR&T lines within each program to prepare for future missions and to drive innovation
- Key international **partnerships**: LISA, UltraSat











science.nasa.gov

nasa.gov/budget

FY2025 Science Budget Request Summary ($M)

	Actual	CR	Request	Out-Years			
	2023	2024	2025	2026	2027	2028	2029
Science	**$7,791.5**	**$7,795.0**	**$7,565.7**	**$7,717.0**	**$7,871.3**	**$8,028.7**	**$8,189.3**
Earth Science	**$2,175.0**		**$2,378.7**	**$2,396.3**	**$2,446.1**	**$2,489.7**	**$2,543.4**
Earth Science Research	$502.0		$606.2	$608.4	$627.6	$628.8	$637.2
Earth Systematic Missions	$915.0		$854.4	$868.7	$888.2	$869.9	$757.8
Earth System Explorers	$2.5		$19.6	$59.0	$99.5	$130.6	$194.7
Responsive Science Initiatives	$55.0		$167.7	$173.9	$176.4	$177.9	$179.5
Earth System Science Pathfinder	$232.1		$251.7	$246.0	$202.1	$225.0	$308.9
Earth Science Data Systems	$291.1		$263.2	$257.6	$268.3	$269.8	$276.3
Earth Science Technology	$102.2		$147.2	$109.4	$110.6	$111.8	$113.0
Applied Sciences	$75.2		$68.6	$73.3	$73.5	$75.8	$75.9
Planetary Science	**$3,216.5**		**$2,731.5**	**$2,850.5**	**$2,911.6**	**$2,976.8**	**$3,042.5**
Planetary Science Research	$310.6		$390.1	$386.4	$392.5	$405.3	$407.8
Planetary Defense	$135.5		$276.6	$369.3	$299.6	$81.0	$78.1
Lunar Discovery and Exploration	$486.3		$458.3	$456.8	$467.8	$479.1	$488.5
Mars Sample Return	$818.8		TBD	TBD	TBD	TBD	TBD
Discovery	$217.5		$261.5	$418.3	$588.0	$790.8	$912.4
New Frontiers	$488.2		$500.5	$533.0	$484.2	$471.6	$298.3
Mars Exploration	$248.1		$324.5	$298.6	$305.8	$353.3	$390.7
Outer Planets and Ocean Worlds	$356.8		$319.0	$197.4	$197.1	$226.3	$304.3
Radioisotope Power	$154.9		$201.1	$190.7	$176.6	$169.4	$162.5

FY2025 Science Budget Request Summary ($M)

	Actual	CR	Request	Out-Years			
	2023	2024	2025	2026	2027	2028	2029
Astrophysics	**$1,510.0**		**$1,578.1**	**$1,587.0**	**$1,613.6**	**$1,647.1**	**$1,673.4**
Astrophysics Research	$284.8		$300.5	$378.7	$390.5	$390.3	$377.1
Cosmic Origins	$314.8		$319.0	$312.8	$307.7	$300.4	$282.1
Physics of the Cosmos	$180.7		$210.8	$184.3	$168.6	$176.1	$133.7
Exoplanet Exploration	$502.9		$478.5	$459.0	$366.1	$323.8	$339.9
Astrophysics Explorer	$226.8		$269.3	$252.2	$380.6	$456.4	$540.6
Heliophysics	**$805.0**		**$786.7**	**$791.9**	**$807.0**	**$820.3**	**$833.4**
Heliophysics Research	$238.2		$252.3	$247.7	$255.8	$257.8	$258.5
Living with a Star	$155.2		$107.7	$100.1	$112.1	$106.3	$101.4
Solar Terrestrial Probes	$198.0		$133.2	$82.9	$64.9	$56.1	$38.1
Heliophysics Explorer Program	$167.9		$236.7	$309.4	$325.4	$355.4	$385.4
Heliophysics Technology	$19.9		$9.3	$9.2	$8.8	$8.8	$15.8
Space Weather	$25.8		$47.5	$42.6	$40.0	$35.9	$34.2
Biological and Physical Sciences	**$85.0**		**$90.8**	**$91.3**	**$93.0**	**$94.8**	**$96.6**

National Aeronautics and Space Administration



NASA Astrophysics Update

Kelly Holley-Bockelmann, Chair, Astrophysics Advisory Committee

Latest APAC meeting – March 20-21, 2024

Wednesday 20 March		
10:00 a.m.	Introduction and Announcements	Hashima Hasan/Kelly Holley-Bockelmann
10:05 a.m.	SMD Associate Administrator Comments	Nicola Fox
10:30 a.m.	Astrophysics Division Update	Mark Clampin
12:30 p.m.	Public Comment Period	
12:45 p.m.	Lunch	
1:45 p.m.	Discussion	APAC members
2:15 p.m.	ExoPAG/PhysPAG/COPAG Updates	Ilaria Pascucci/Athina Meli/Shouleh Nikzad
3:00 p.m.	Break	
3:15 p.m.	TDAMM ACROSS Report	Jamie Kennea
3:45 p.m.	TDAMM ACROSS Discussion	APAC members
5:00 p.m.	Wrap up for Day 1	Kelly Holley-Bockelmann
Thursday 21 March		
9:00 a.m.	Opening Remarks	Hashima Hasan/Kelly Holley-Bockelmann
9:05 a.m.	LISA Update	Ira Thorpe
9:30 a.m.	Roman Update	Jeff Kruk
10:00 a.m.	Euclid Update	Mike Seiffert
10:20 a.m.	Break	
10:40 a.m.	XRISM Update	Richard Kelly
11:00 a.m.	GUSTO Update	Chris Walker
11:30 a.m.	Open Software Discussion	Rebecca Larson/Natasha Batalha/Kelle Cruz
12:00 p.m.	Lunch - UVEX Explorer	Fiona Harrison
1:00 p.m.	Discussion of Open Software	APAC members
1:30 p.m.	Public Comment Period	
1:40 p.m.	Discussion of APAC topics from the community	APAC members
2:10 p.m.	Break	

APAC Themes

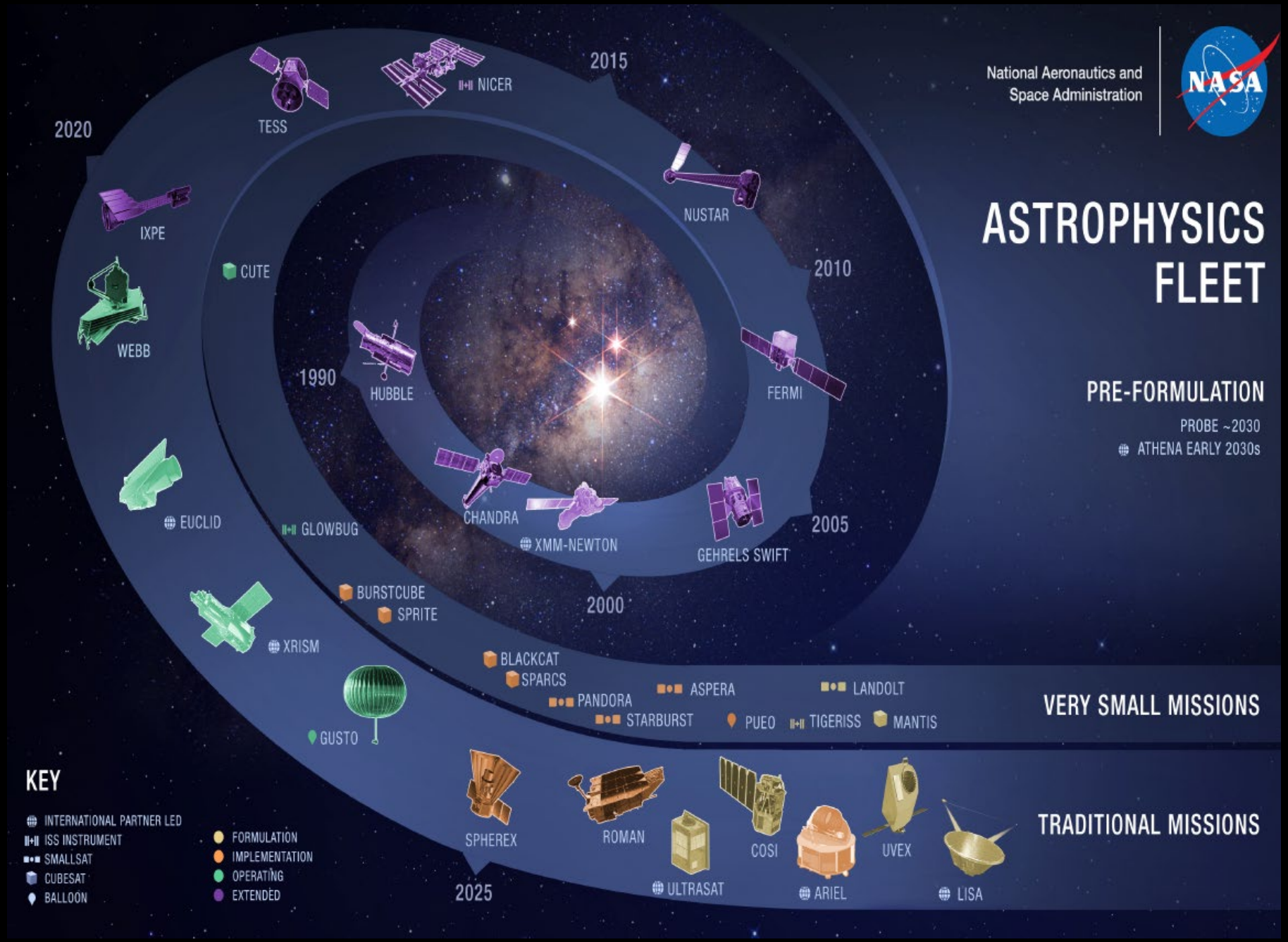
Chandra and Hubble in danger

Aging communications infrastructure

Re-envisioning Explorers Program

A new open software paradigm

Time domain and multi messenger astronomy


National Aeronautics and Space Administration
NASA
ASTROPHYSICS FLEET
2015
2020
2010
1990
2005
2000
2025
TESS
NICER
IXPE
NUSTAR
CUTE
WEBB
HUBBLE
FERMI
CHANDRA
XMM-NEWTON
GEHRELS SWIFT
EUCLID
GLOWBUG
BURSTCUBE
SPRITE
XRISM
BLACKCAT
SPARCS
PANDORA
ASPERA
LANDOLT
STARBURST
PUEO
TIGERISS
MANTIS
GUSTO
VERY SMALL MISSIONS
SPHEREX
ROMAN
COSI
UVEX
ULTRASAT
ARIEL
LISA
TRADITIONAL MISSIONS
PRE-FORMULATION
PROBE ~2030
ATHENA EARLY 2030s
KEY
INTERNATIONAL PARTNER LED
ISS INSTRUMENT
SMALLSAT
CUBESAT
BALLOON
FORMULATION
IMPLEMENTATION
OPERATING
EXTENDED

Operations Paradigm Change Review (OPCR)

The APD will host an Operations Paradigm Change Review (OPCR) of the CXO and HST missions in 2024. The OPCR will assess proposed options for approaches to continue operations of missions in the extended operations phase, with reduced funding as proposed in the FY2025 President's Budget. The purpose of the review is to assist NASA in assessing the potential for limited scientific productivity and decreased operating efficiency of the HST and CXO missions under the current and future budget realities. NASA will use the findings from the OPCR to:

- Define an implementation approach consistent with astrophysics strategic objectives,
- Prioritize the operating mode(s),
- Provide programmatic direction to the missions concerned for FY25-FY28; and
- Issue initial funding guidelines for FY29 and FY30

NASA actions resulting from the OPCR could include authorizing a mission to; maintain the status quo; restructure the project; or terminate an ongoing science mission.



Utmost community concern

Budget cuts to Chandra and Hubble that already cut into operations, guest investigator grants, and more to come.

APAC Concern

The process to review Chandra and Hubble programs is happening out of public or APAC view.


SCaN
National Aeronautics and Space Administration
NASA
SCaN Update: TDRSS, DSN, and LEGS
Presented to:
NASA Astrophysics Advisory Committee (APAC)
October 20th, 2023
Presented by:
Dr. Jeffrey Hayes
Discipline Scientist, Science Mission Directorate
On Detail to the Space Communications and Navigation (SCaN) organization
Space Operations Mission Directorate
National Aeronautics and Space Administration
SCaN
Space Communications and Navigation
Exploration, enabled.

APAC SCaN Findings and Recommendations

Space Communications and Navigation infrastructure is in dire need of maintenance and critical upgrades. Both the Near Space Network (NSN) and the Deep Space Network (DSN) are aging and severely oversubscribed, with demand exceeding capacity continuously over the last decade. The Artemis campaign required more than 5 times the resources of a typical launch, which impacted APD missions TESS and particularly JWST. In addition, the prioritization of CubeSats resulted in an overall loss of science from the rest of the APD mission suite.

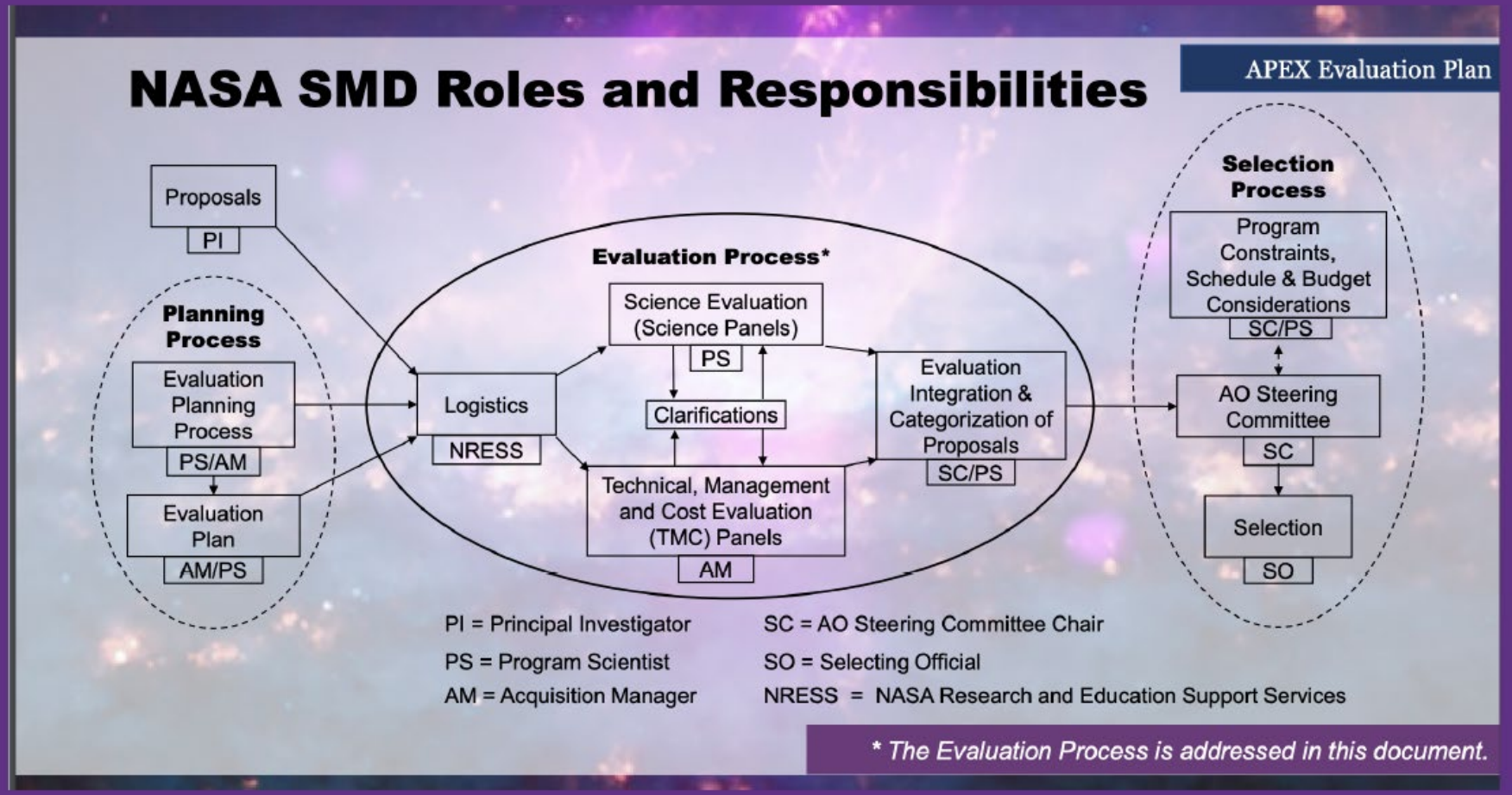
Given the relatively high costs associated with maintaining and building on existing communications infrastructure (primarily related to TDRSS and DSN), and the recent successes of the Deep Space Optical Comm (DSOC) demo on the Psyche mission and with the Integrated Laser Communications Relay Demonstration Low Earth Orbit User Modem and Amplifier Terminal (ILLUMINA-T) with Laser Communications Relay Demonstration (LCRD) on ISS, the APAC recommends that APD explore the benefits, feasibility, and possible future implementation of optical communications on astrophysics missions. Further, we recommend a Request for Information to better understand the space communication needs and concerns of the astrophysics community, as well as to explore the applicability and timescale of optical services to APD missions.

EXPLORERS PROGRAM

- Home
- Missions
  - MIDEX
  - SMEX
  - UNEX/MO/Internationals
- History
- Announcement of Opportunity
- Newsroom
- Images and Multimedia
- Meet the Team



APAC – earlier downselect based on science and feasibility, with stronger constructive review



From APEX presentation, 1/2024

Community Concerns on the Adoption of Open Science in Astrophysics

APAC Discussion



Natasha E. Batalha (NASA Ames Research Center) March 21, 2023
My OS experience: TOPS Champion, former Project Scientist for TOPS OpenCore, led OpenCore Model on Open Results, creator of many OS tools/codes, Planetary Data System User Community

OpenCore: https://nasa.github.io/Transform-to-Open-Science/take-os101/

Four Concerns Facing Adoption of OS

1. Concern that there are no realistic avenues to support maintenance/infrastructure of open source software, open database, libraries

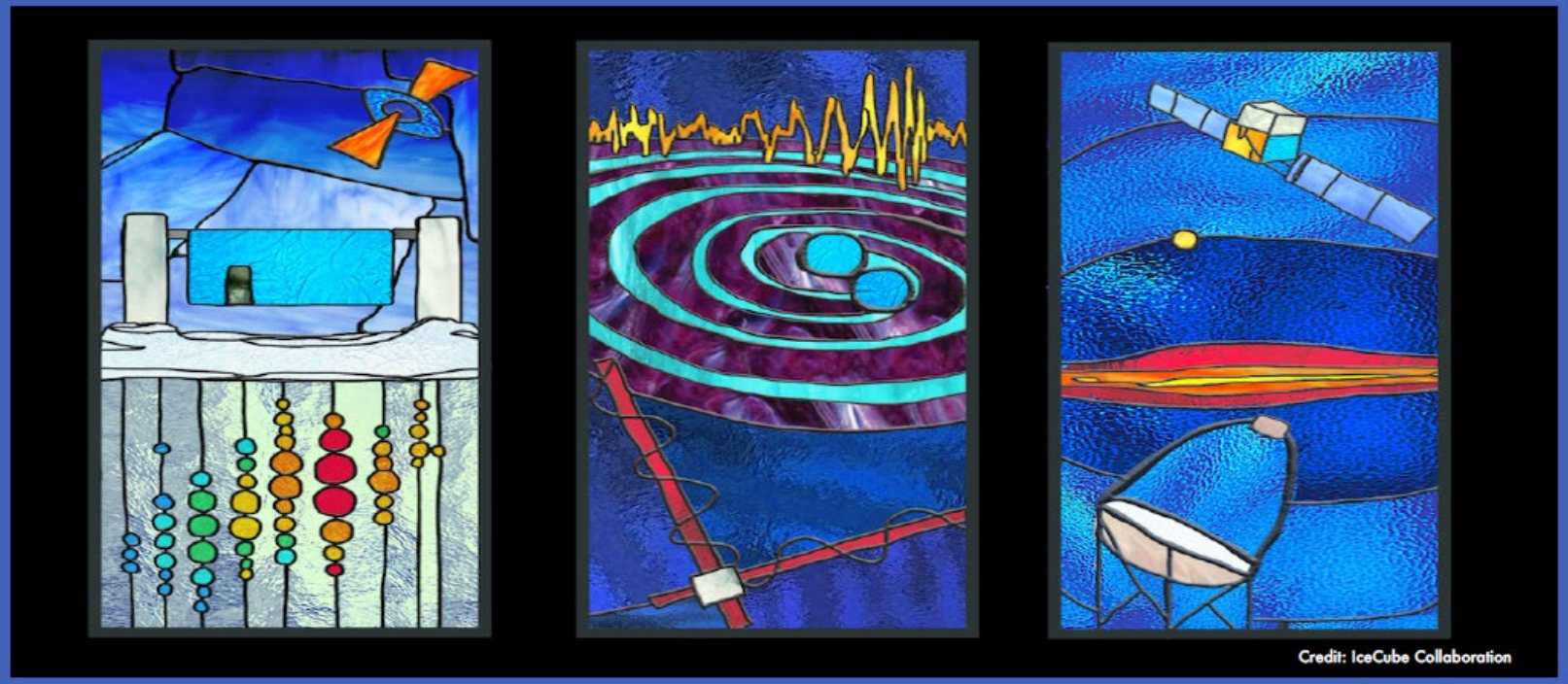
2. Concern that the development of OS requirements have not been met with the development of new incentives for adoption

3. Concern that there are no standards regarding the definition and requirements of “an open reproducible paper”

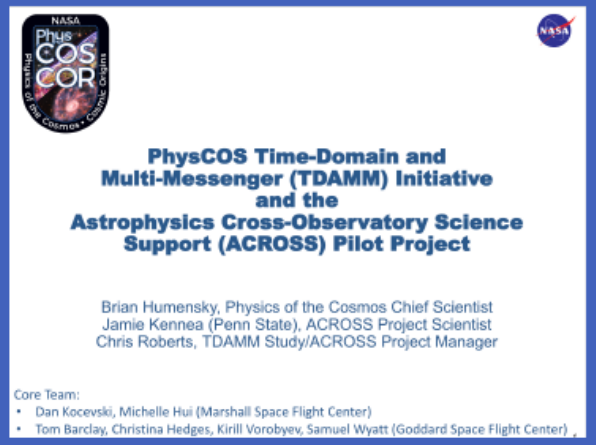
4. Concern with open data, elimination of exclusive access periods and being scooping

And these are all fully addressable!

Time Domain and Multimessenger Astronomy (TDAMM)



Astro2020 Decadal Survey: TDAMM = highest priority sustaining activity for NASA Astrophysics. Recommended $500-800M investment this decade.



PhysCOS Time-Domain and Multi-Messenger (TDAMM) Initiative and the Astrophysics Cross-Observatory Science Support (ACROSS) Pilot Project

Brian Humensky, Physics of the Cosmos Chief Scientist
Jamie Kennea (Penn State), ACROSS Project Scientist
Chris Roberts, TDAMM Study/ACROSS Project Manager

Core Team:
- Dan Kocevski, Michelle Hui (Marshall Space Flight Center)
- Tom Barclay, Christina Hedges, Kirill Vorobyev, Samuel Wyatt (Goddard Space Flight Center)

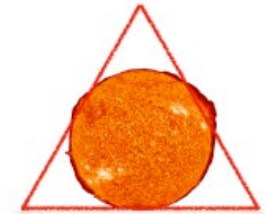
TDAMM relies on SCaN, new infrastructure, and workforce development

- **The Astrophysics Cross-Observatory Science Support (ACROSS) pilot project is an outcome of the first year of the TDAMM study, which identified needs for:**
  1. Software & data systems to facilitate TDAMM science workflows,
  2. TDAMM help desk to provide expertise & facilitate coordination, and
  3. TDAMM community grant program to incentivize scientific innovation.
- **The ACROSS core team members are from PhysCOS, Goddard, Marshall and Penn State.**

The objective of the pilot phase is to put ACROSS on a path to becoming a Center of Excellence for enabling TDAMM science.

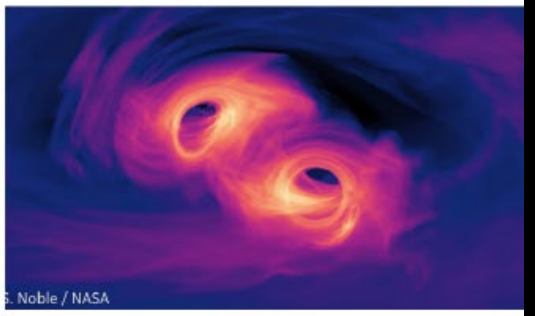
ESA/NASA adopted the Laser Interferometer Space Antenna (LISA) gravitational wave mission – the future of multimessenger astronomy





$2\sqrt{3}R_\odot \approx 2.4\,\mathrm{Gm}$

Spacetime seismometer the size of a star to launch in 2035 and will detect massive black hole mergers





Biological and Physical Sciences Advisory Committee Report

Dr. Jamie Foster
Chair BPAC (effective March 2024)

NASA Advisory Council Science Committee
Spring 2024
March 25, 2024

Biological and Physical Sciences

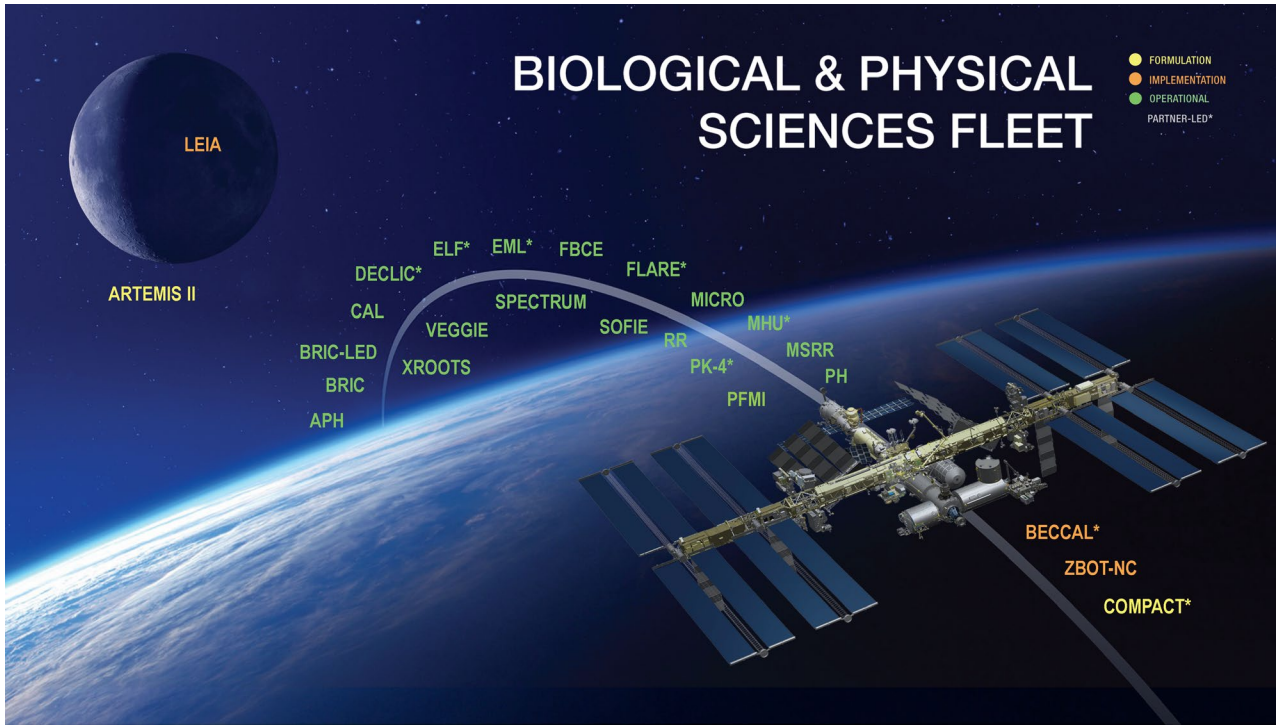
https://science.nasa.gov/biological-physical/data

The Biological and Physical Sciences (BPS) Division's mission is two-pronged:

- pioneer scientific discovery
- enable human spaceflight exploration

BPS supports experiments on biological and physical systems in:

- ground-based laboratories
- on aircraft
- in sub-orbital flight
- the ISS and beyond low-Earth orbit



Working with academic, commercial, agency and international partners is central to BPS mission
BPS make data available across the spectrum of research areas that BPS supports



BPS - Open Science Platforms

Cross Disciplinary

- **Task Book** – current and upcoming research projects; annual reports from funded projects
    - Link for Taskbook, GeneLab, LSDA and PSI

Biology

- **GeneLab** – molecular biology / “omics” data and metadata
- **Ames Life Sciences Data Archive (ALSDA)** – life sciences research data and information from decades of spaceflight and ground-analog research involving human, microbe, plant, and animal subjects.
- **NBISC** – Non -human biorepository of the Institutional Scientific Collection at Ames Research Center

Physical Sciences

- **Physical Science Informatics (PSI)** – repository for physical science experiments performed on the ISS



BPAC Activities: Past and Future

BPAC Charter Signed and Advisory Committee Appointments: Fall 2023

No formal meeting of BPAC to date – an informal meeting of experts in November 2022 and December 2023

First Formal BPAC Meeting: April 25-26, 2024

BPAC Meeting Schedule: Spring 2024 (in person) and Fall 2024

List of Committee Members:

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



NATIONAL ACADEMIES Sciences Engineering Medicine

Thriving in Space: Decadal Survey for the Biological and Physical Sciences in Space 2023 - 2032

OFFICIAL REPORT RELEASE DATE

Tuesday, September 12, 2023

Space Science Week 2024

Committee on Biological and Physical Sciences in Space

March 19 – 20, 2024

BPS Division Status and SMD response to Decadal Survey

Lisa Carnell, Director BPS

Biological and Physical Sciences
Biological Sciences Highlights

Growing *Arabidopsis* in Lunar Soil



Crop Production in Microgravity



Tissue Chip Investment



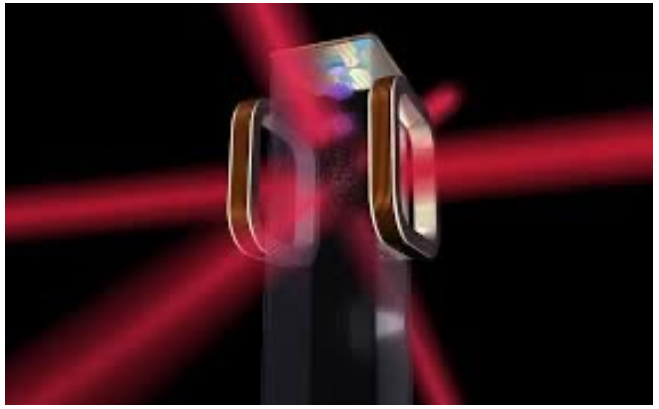
Questions to address as ISS is reaching max capacity:

How will BPS work to increase that efficiency to increase scientific experimental throughput?

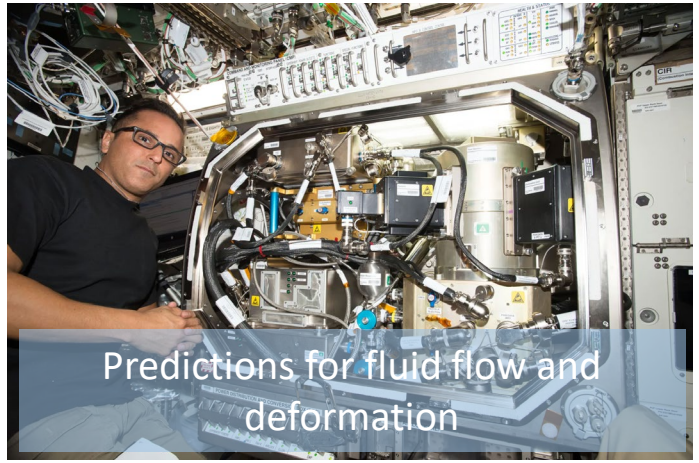
What will the continuity of these activities look like on on CLDs?

Biological and Physical Sciences
Physical Sciences Highlight

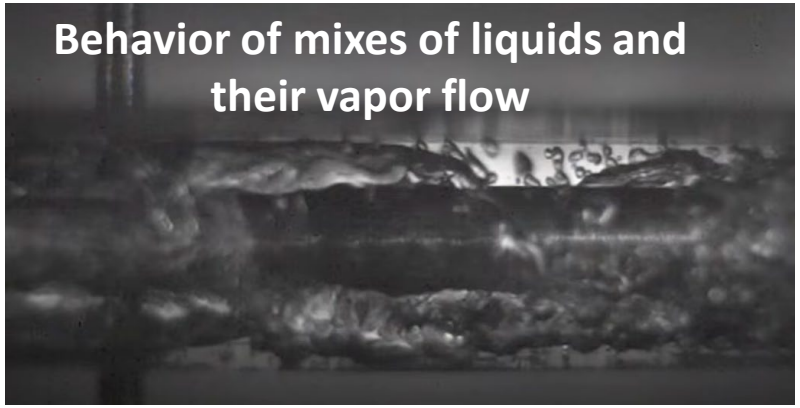
Cold Atom Lab – Quantum Physics



Zero-Boil-Off-Tank (ZBOT) Microgravity



Flow Boiling Condensation

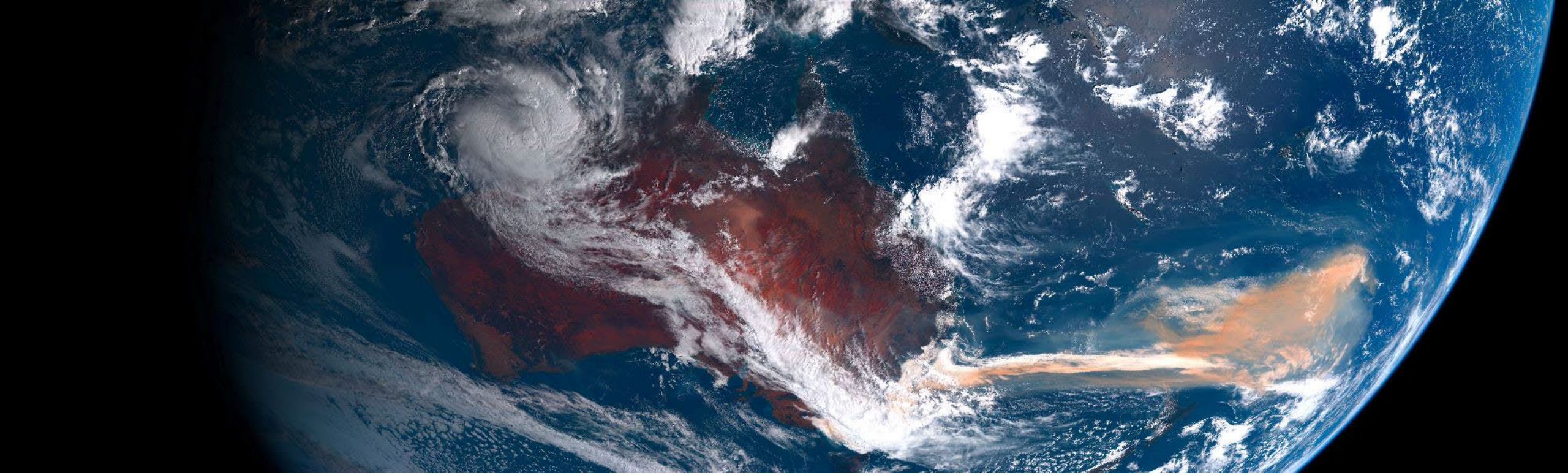


Questions to address as ISS reaches end of life:

How will the CAL and other key physics experiments continue beyond ISS?

Could hardware be transferred to a future CLD? (e.g., Axiom)

Could CAL be expanded by receiving investment from other federal agencies ?



Earth Science Advisory Committee (ESAC) Report

Sara Tucker, ESAC Chair

NASA Advisory Council Science Committee

25 March 2024 - Virtual

NASA Earth Science Advisory Committee

- ESAC Executive Secretary - Lucia Tsaoussi
- ESAC Members
  - Indrani Das – LDEO, Columbia University
  - Belay Demoz - JCET, University of Maryland, Baltimore County
  - Venkataraman Lakshmi - University of Virginia
  - Jennifer Logan - Northrop Grumman Aerospace Systems
  - Rowena Lohman - Cornell University
  - Beth Plale - Indiana University
  - Robert Wright - University of Hawaii
  - Lisan Yu - Woods Hole Oceanographic Institution
  - Anastasia Romanou - Columbia University
  - Jennifer Watts – Woodwell Climate Research Center
  - Christine Chiu – Colorado State University
  - Dylan Millet – University of Minnesota
  - Sara Rivero-Calle – University of Georgia
  - Helen Pilar – University of Texas
  - Melanie Preisser – York Space Systems
  - Sara Tucker, Chair – BAE Systems, Space & Mission Systems

Previous ESAC meeting: GPRAMA Report Review

- Virtual meeting held 19 October 2023
- Review report on R&A efforts using data from NASA observation systems
  - 154 pages highlighting 338 publications on work supported by ESD.
  - Covers research and analysis efforts supported by the NASA ESD Focus Areas
    - Atmospheric Composition
    - Carbon Cycle & Ecosystems
    - Climate Variability & Change
    - Earth Surface & Interior
    - Water & Energy Cycle
    - Weather & Atmospheric Dynamics
- ESD Science Annual Performance Goals
  - 1.1.8: NASA shall demonstrate progress in characterizing the behavior of the Earth system, including its various components and the naturally-occurring and human-induced forcings that act upon it;
    and
  - 1.1.9: NASA shall demonstrate progress in enhancing understanding of the interacting processes that control the behavior of the Earth system, and in utilizing the enhanced knowledge to improve predictive capability.
  - The ESAC unanimously voted Green for both ESD Science Annual Performance Goals , indicating that the committee found the science objectives fully met for 2023

Previous ESAC meeting, continued

- Unidentified Aerial Phenomena Independent Study Team (UAPIST) Report Summary
  - UAPIST is a subcommittee formed under the ESAC
  - Daniel Evans (UAPIST Designated Federal Officer) and David Spergel (UAPIST Chair)

ESAC Findings:

- The ESAC finds that the UAPIST Subcommittee has addressed the questions outlined in the Statement of Task, and thereby has met its Terms of Reference.
- The ESAC finds that the scope of the Subcommittee report, including any recommendations, is beyond NASA's Earth Science program.

ESAC Procedural Recommendation

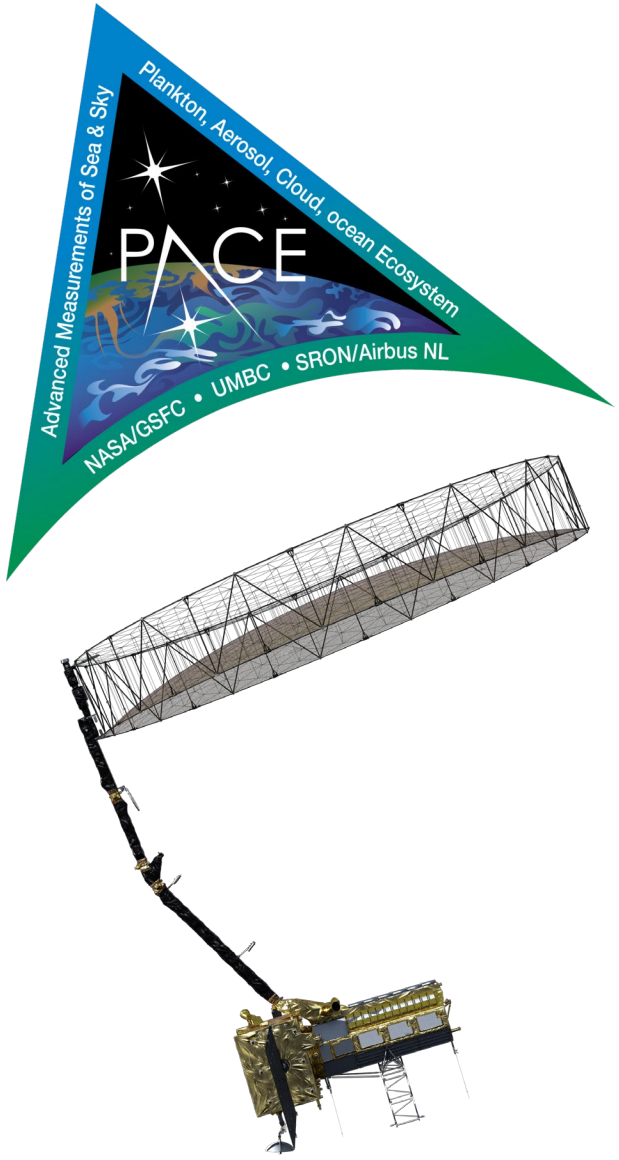
- The ESAC does not have the expertise to make detailed recommendations to ESD regarding the report. The ESAC accordingly recommends that the report be conveyed to agency leadership.

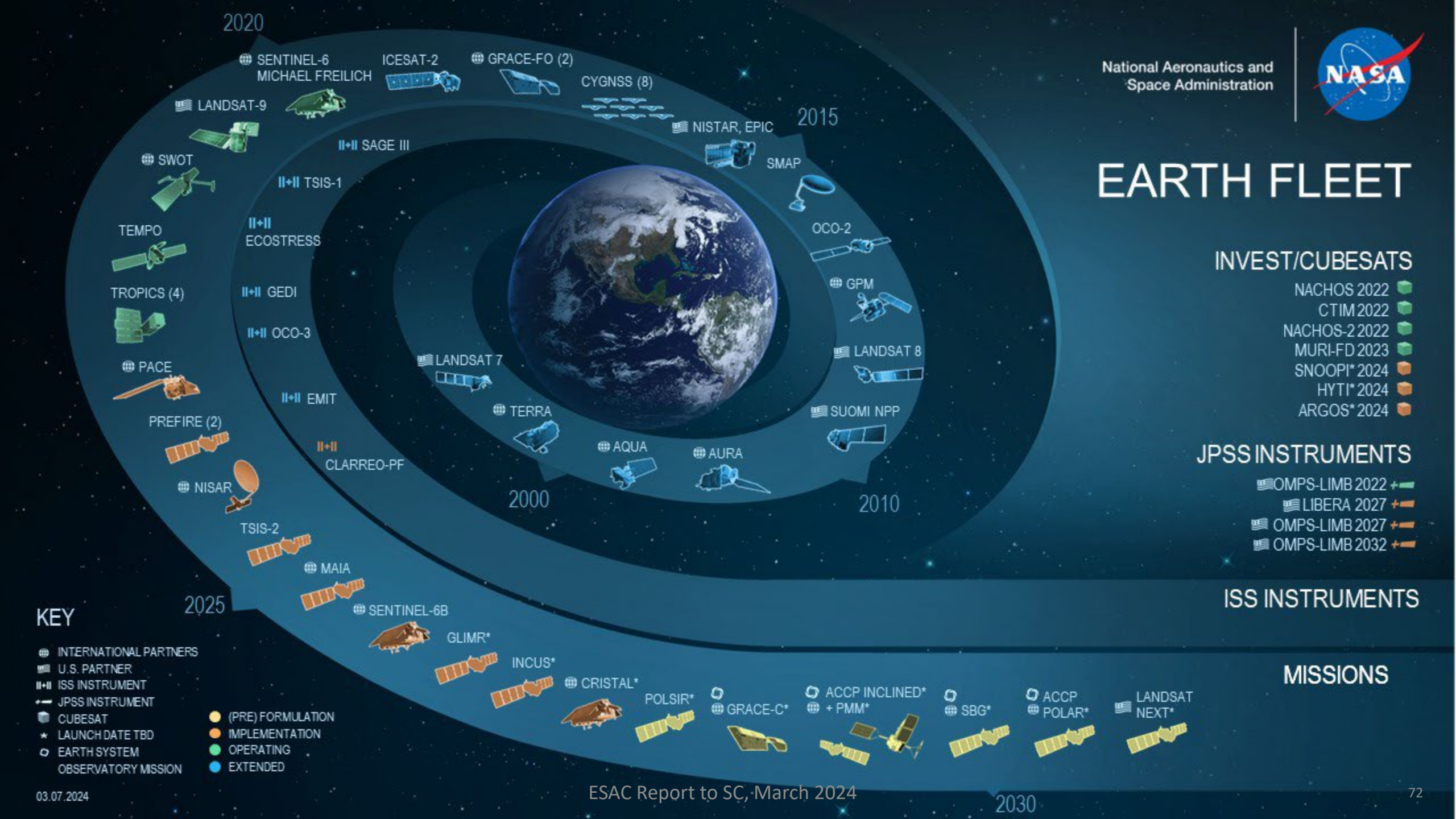
Other ESAC Updates

- New members approved and added
- Next Meeting: Planned for 16-17 April 2024 [in-person at HQ]
  - To include joint meeting time with Applied Sciences Advisory Committee

Earth Science Division Highlights

- Community Forum: 13 March 2024
  - Focus on budget, climate-change responsive science initiatives, upcoming changes to decadal missions (particularly the Atmospheric Observing System – AOS), and Earth Venture line.
- PACE Launch: 8 February 2024
  - Plankton, Aerosol, Cloud, ocean Ecosystem
  - Ocean Color Instrument (Spectrometer) & Bus: GSFC
  - SPEXone (Spectro-Polarimeter for Planetary Exploration): multi-angle polarimeter (SRON and Airbus DS NL-Netherlands)
  - HARP2 (Hyper-Angular Rainbow Polarimeter #2): UMBC's Earth and Space Institute
- Upcoming NASA-ISRO SAR (NISAR) Launch: Spring 2024
  - Polarimetric Synthetic Aperture Radar: L band (NASA) and S band (ISRO)
  - Earth's Dynamic Surface & Interior, Earth's Cold Regions, Terrestrial Ecosystems, and Water/Coastal Processes




National Aeronautics and Space Administration
NASA
EARTH FLEET
2020
2015
2010
2000
2025
2030
SENTINEL-6 MICHAEL FREILICH
ICESAT-2
GRACE-FO (2)
CYGNSS (8)
LANDSAT-9
NISTAR, EPIC
SAGE III
SWOT
SMAP
TSIS-1
OCO-2
TEMPO
ECOSTRESS
GPM
TROPICS (4)
GEDI
LANDSAT 8
OCO-3
LANDSAT 7
PACE
SUOMI NPP
EMIT
TERRA
PREFIRE (2)
AQUA
AURA
CLARREO-PF
NISAR
TSIS-2
MAIA
SENTINEL-6B
GLIMR*
INCUS*
CRISTAL*
POLSIR*
GRACE-C*
ACCP INCLINED* + PMM*
SBG*
ACCP POLAR*
LANDSAT NEXT*
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
KEY
INTERNATIONAL PARTNERS
U.S. PARTNER
ISS INSTRUMENT
JPSS INSTRUMENT
CUBESAT
LAUNCH DATE TBD
EARTH SYSTEM OBSERVATORY MISSION
(PRE) FORMULATION
IMPLEMENTATION
OPERATING
EXTENDED
03.07.2024





PACE Advances Ocean Science

- Monitors fisheries
- Respond to toxic algae blooms
- Key ocean and atmosphere data for forecasting air quality and weather that will improve our understanding of Earth's Climate
- Anticipated launch early 2024



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

Paul Cassak, West Virginia University and HPAC Chair, March 25, 2024

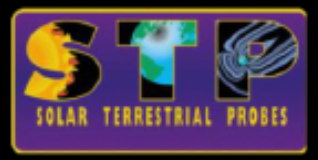
NASA HELIOPHYSICS OBJECTIVES

- Solve the **fundamental physics** mysteries of heliophysics: Explore and examine the physical processes in the space environment from the Sun to the Earth and throughout the solar system including the interface with the interstellar medium.
- Build the **knowledge to forecast space weather** throughout the heliosphere: Develop the knowledge and capability to detect and predict extreme conditions in space to protect life and society and to safeguard human and robotic explorers beyond Earth.
- Understand the **nature of our home in space**: Advance our understanding of the connections that link the sun, the Earth, planetary space environments, and the outer reaches of our solar system.

The NASA HQ Heliophysics Division













We're back!

- Recent HPAC Meetings
  - November 14-16, 2023
  - February 12-13, 2024
- Previous Meeting
  - September 20-21, 2022
- Next Meeting
  - June or July, 2024

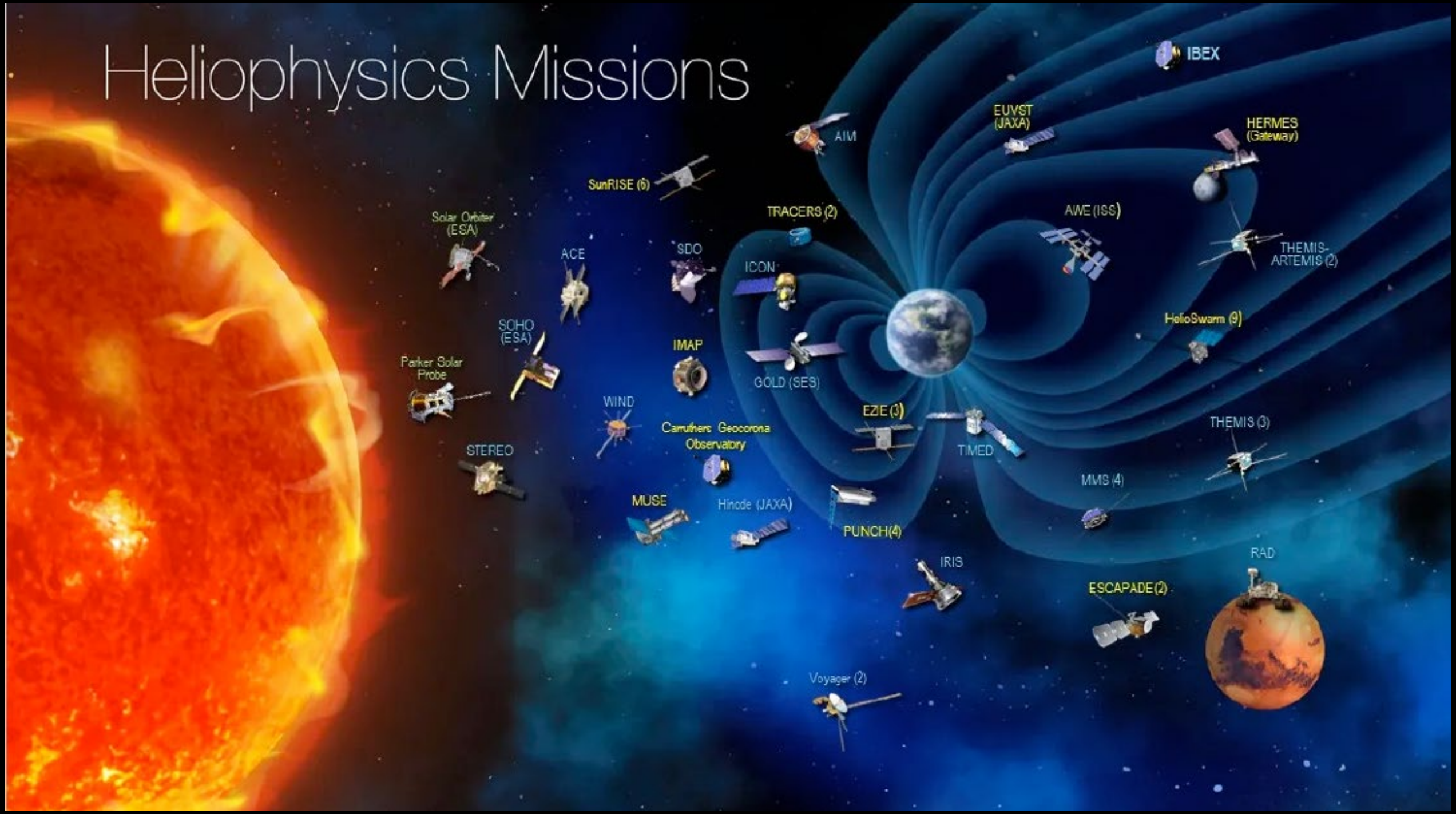


Kubrick, S. (1980). The Shining. Warner Bros.

HPAC Committee Members

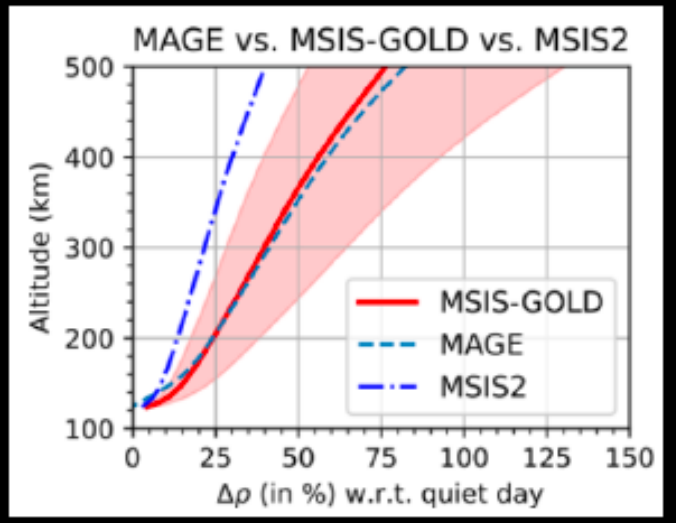
HPAC Designated Federal Officer - Janet Kozyra

- Aroh Barjatya (Embry-Riddle Aeronautical University)
- Dave Brain (University of Colorado, Boulder)
- Paul Cassak (West Virginia University), Chair
- Nicole Duncan (Ball Aerospace)
- 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, Berkeley)
- Barbara Thompson (NASA Goddard Space Flight Center - Nov. 2023 meeting only)
- Lisa Upton (Southwest Research Institute)
- Marco Velli (University of California, Los Angeles)
- Jia Yue (Catholic University)
- Eric Zirnstein (Princeton University)


Heliophysics Missions
IBEX
EUVST (JAXA)
HERMES (Gateway)
AIM
SunRISE (6)
TRACERS (2)
AWE (ISS)
Solar Orbiter (ESA)
ACE
SDO
ICON
THEMIS-ARTEMIS (2)
SOHO (ESA)
HelioSwarm (9)
IMAP
Parker Solar Probe
GOLD (SES)
WIND
EZIE (3)
THEMIS (3)
Carruthers Geocorona Observatory
STEREO
TIMED
MMS (4)
MUSE
Hinode (JAXA)
PUNCH(4)
IRIS
RAD
ESCAPADE(2)
Voyager (2)

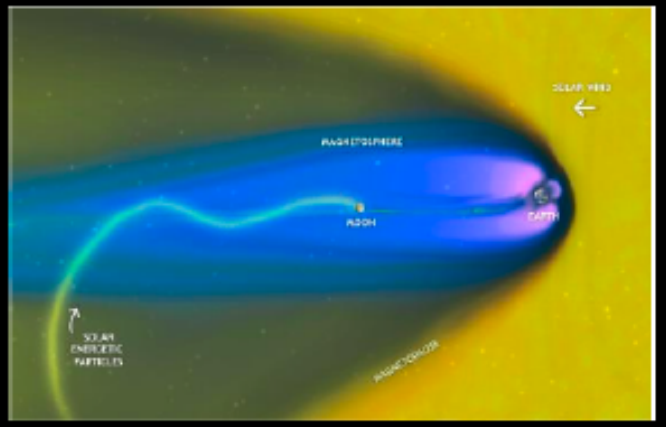
Recent Heliophysics Highlights

- **In February 2022, 38 commercial satellites that were launched into a low Earth orbit in preparation for subsequent orbit-raising maneuvers were lost to premature reentry. This was the result of increased aerodynamic resistance on the satellites caused by an atmospheric density increase resulting from a minor eruption in the Sun's atmosphere.** While it was well-known that upper atmospheric densities, and therefore the aerodynamic drag forces on satellites, are highly variable, recent observations by NASA's Global-scale Observations of the Limb and Disk (GOLD) mission shed light on this specific event. The changes in upper atmospheric temperature and composition were studied. Not only did the instrument verify that there was a significant increase in upper atmospheric density for this time period, it provided details on the spatial and temporal response of the upper atmosphere to this specific solar eruption. These studies powerfully demonstrate the necessity to observe the upper atmospheric environment in order to advance the capability to detect and gain quantitative understanding of the space environment's response to external drivers and, ultimately, to develop the capability to create accurate forecasts.



Laskar et al. (2023), *Space Weather*, https://doi.org/10.1029/2022SW003349

- The space environment of the Moon changes over the course of its orbit as it moves periodically in and out of regions influenced by Earth's magnetic field (the magnetosphere). One might therefore expect Earth's magnetic field to periodically shield the Moon from energetic particles from the Sun or beyond. However, recent measurements from NASA's Wind and Acceleration, Reconnection, Turbulence and Electrodynamics of the Moon's Interaction with the Sun (ARTEMIS) missions show that these **outside particles have just as much access to the Moon when it is situated behind Earth, deep in the magnetosphere.** This is because particles sneak into Earth's magnetosphere well behind the Earth and Moon, where Earth's magnetic field strength is very low. Guided by Earth's magnetic field, the particles then travel back towards Earth, encountering the Moon. This work has implications for whether strong planetary magnetic fields truly shield planets from energetic events from the Sun.



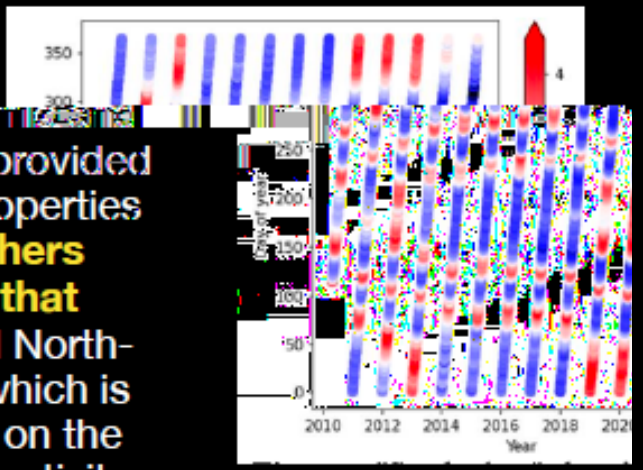
Liuzzo et al., Geophys. Res. Lett., 2023, https://doi.org/10.1029/2023GL103990

Recent Heliophysics Highlights

- The hot plasma (ionized gas) just beneath the Sun's surface moves in complex patterns. These plasma flows are a crucial aspect to the generation of magnetic fields that create sunspots, which in turn are the source of magnetic eruptions that cause extreme space



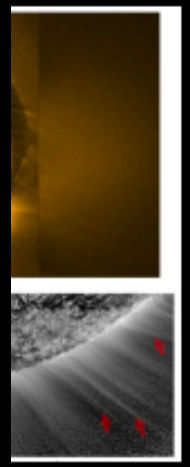
041-8213/acd93f



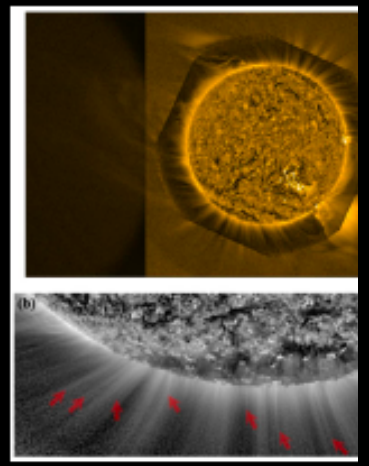
Magnetic Imager (HMI) on NASA's Solar Dynamics Observatory spacecraft has provided more than thirteen years of high-quality data that has been used to study the properties of the magnetic fields and plasma flows of the Sun. By using HMI data, **researchers recently discovered oscillations of the global flows in the Sun's outer layer that were not known before**. These oscillations occur in both East-West (zonal) and North-South (meridional) flows and happen over a period of about one solar rotation (which is roughly 27 days). These results are important for determining how plasma flows on the Sun impact the magnetic fields and will help us understand the Sun's magnetic activity cycle. Understanding the origin of these variations is fundamental to the prediction of extreme conditions in space.

Bogart et al., 2023, ApJLett, DOI: 10.3847/2

- The mechanism that accelerates the solar wind from the Sun's atmosphere into interplanetary space is a long-standing problem in heliophysics. It has important implications for the prediction of space weather responses on Earth. **Recent measurements from NASA's Parker Solar Probe (PSP) mission show evidence that magnetic reconnection, a process that can convert energy to accelerating particles, is a likely candidate for driving the solar wind**. The implications of this affect our understanding of the source and properties of the solar wind passing by Earth and can be integrated into space weather modeling to better predict the impact of space weather at Earth.



(2023)



Raouafi et al., ApJ, 945, 2

Recent Meetings

- November 14-16, 2023
  - HPAC Charter and Operating Procedures, Janet Kozyra
  - HPD Division Update, Peg Luce
  - Space Weather Council and Space Weather Action Group summary, Nicole Duncan
  - Space Weather Program Update, James Favors and Genene Fisher
  - R&A Update, Patrick Koehn
  - Solar Max/Heliophysics Big Year, Janet Kozyra
  - IDEA, Kelly Korreck
  - Heliophysics Big Year – Solar Eclipse, Kelly Korreck
  - HEliophysics Strategic Technology Office (HESTO), Roshanak Hakimzadeh
  - Heliophysics Digital Resource Library, Matt McClure
- February 12-13, 2024
  - Heliophysics Division Update, Joseph Westlake
  - Discussion & Comments on Space Weather Council (SWC) report, Nicole Duncan
  - Distinguishing NASA and NOAA Space Weather Programs, Jamie Favors
  - Europa Clipper & JUICE missions cruise phase coordination, Louise Prockter & Emma Bunce
  - Requirements for Different R&A Programs, Patrick Koehn
  - IDEA – Update on inclusion plans and evaluation procedures in HPD ROSES, Susanna Finn

Report from Meetings I

- November 2023: GPRAMA - Unanimously voted green, 12 F&R,
- Discussion points relevant to SMD
  - Successful launch and first light of Atmospheric Waves Experiment (AWE)
  - Establishment of HEliophysics Strategic Technology Office (HESTO)
    - We recommend HESTO consider broadening strategic technologies such as computational technologies including machine learning
  - Efforts on open data - We commend the Heliophysics Digital Resource Library in their effort to unify access to HSO data resources to streamline the process for users to find data and/or tools they require more easily, and to create an Open Science infrastructure
  - Thoughtful efforts supporting the advancement of IDEA at NASA HPD
  - The Space Weather Council (SWC), an HPAC subcommittee chaired by Dr. Nicole Duncan, is undertaking an impressive array of activities
  - Appointing a new Division Director, Dr. Joseph Westlake
  - Being a part of the quad agency memorandum of agreement for space weather R2O2R collaborations
  - We commend and strongly encourage NASA-NOAA collaborative efforts on space weather as well as keeping the Space Weather Council informed on their activities. We find the End-to-End Space Weather TableTop Exercise (TTX) planned for May 2024 is an impactful way for stakeholders to engage across the space weather enterprise and make progress towards the Implementation Plan released in December 2023
  - Europa Clipper and JUICE are upcoming missions to Jupiter and some of its moons including Europa sponsored by NASA and ESA. We find this to be an excellent opportunity to leverage these missions to advance understanding of small- and large-scale physics relevant to HPD goals
  - Successful outreach associated with the recent annular eclipse
  - Heliophysics Big Year (HBY) is an exciting theme for the community to build upon during solar maximum 25 and the total solar eclipse in 2024



International Geophysical Year IGY 1957-58

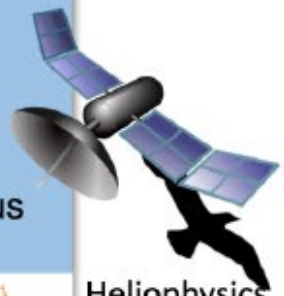
- Radiation Belts
- Sputnik, Explorer I
- Plate Tectonics
- Established NASA
- Nations working together

International Heliophysics Year IHY 2007-8

- 50-year Anniversary IGY
- Space Weather
- Scientific Cooperation
- Scientific Capacity Building

Heliophysics Big Year HBY 2023-24

- Citizen Science
- Solar Eclipses
- Sun-Geospace System Focus
- Approach to Solar Max
- Solar Superstorm Dynamics



Heliophysics "Birds", take over for Solar Max

1957-58

- International Solar Terrestrial Physics Program,
- Heliophysics System Observatory Created

2007-8

- Parker Solar Probe: Touch the Sun
- Solar Dynamics Observatory: Big Data
- HSO expanded to 20 operating missions, 2 missions in development, 10 in formulation
- Citizen Science invaluable contributor to science discovery

2023-24



Citizen Science in the Big Year



Slide taken from Solar Max/Heliophysics Big Year, Janet Kozyra, HPAC Meeting, Nov. 15, 2023

Implementation: Heliophysics Big Year, Solar Maximum

As was done in IGY and IHY, the goal is to come together and look for synergistic opportunities that present pathways to scientific advancement with immense potential.

HBY enables us to address ambitious research questions using complementary skills and resources, join efforts through open science across programs, science communities, individual researchers, and citizen scientists, each enriching the others, while actively focusing on inclusion, diversity, equity, & accessibility in ways that:

- Generate excitement
- Enable new discoveries
- Give us quick wins on the time scale of the HBY
- Create legacy associations that will live on after HBY
- Enable innovative, comprehensive analysis of dangerous solar storms

1. Recruit internal NASA and external working groups to:

Develop overall strategy and plans for the first workshop in early 2024 and future interactions

2. Launch "HBY Solar Max" workshop with 3 elements

- Pilot studies of two major storms that occurred in March and April of 2023 (and possibly another in November 2023) associated with red aurora at low latitudes, and other unusual phenomena, with great potential for giving insights into superstorm dynamics.
- Joint session with citizen scientists to integrate their data & inputs of science questions
- Brain-storming sessions to collect input on needed infrastructure based on the pilot studies

3. Seek out mutually beneficial synergies between programs, including:

Year of Open Science	ISWAT	AWS	ISTPNext
SMD Citizen Science	HSO missions	Google	More!
IDEA group	DRIVE Science Centers	CCMC/GSFC	

4. Prioritize IDEA (inclusion, diversity, equity, accessibility) & public outreach

- Ensure that the external advisory group members span diversity elements to guide campaigns and develop plans for infrastructure. Accessibility will be a key consideration.
- Participate in interactions with the public that increase their level of engagement and enhance understanding of space weather, space climate, and societal impacts

5. Optimize existing tools & develop others (when possible)

- Internal and external communications,
- System-level data products for HSO
- Algorithms to stitch together auroral images
- More!

Slide taken from Solar Max/Heliophysics Big Year, Janet Kozyra, HPAC Meeting, Nov. 15, 2023

NASA Priorities for 2024 Total Solar Eclipse

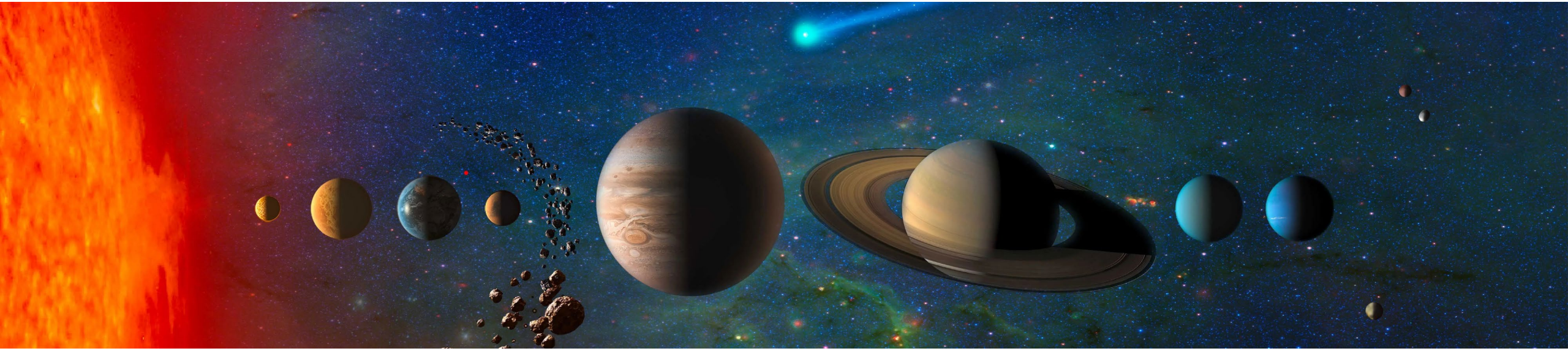
Safety
Broadening Participation
Science
Public Engagement
Science Activation
Citizen Science



Slide taken from Heliophysics Big Year – Solar Eclipse, Kelly Korreck, HPAC Meeting, Nov. 15, 2023

Report from Meetings II

- The current flagship mission Geospace Dynamics Constellation (GDC), to study processes that govern the dynamics of the Earth's upper atmospheric that surrounds and protects the planet, is delayed. It is in Phase A and instruments teams have already been selected. There is concern the mission will be unable to be implemented with the new Decadal Survey release imminent.
- We are concerned about the level of funding resources for HPD both now and in the notional out years; funding issues run the risk of compromising the division's ability to achieve its goals and risk disrupting the balance of the division's portfolio.
- To assess the health of the R&A program, we recommend HPD include the success rate for proposals that were evaluated as VG-E (Very Good - Excellent) and E (Excellent)
- We commend HPD on the implementation of Dual Anonymous Peer Review (DAPR) for many competed research opportunities. We recommend that HPD continue the assessment and tracking of the impact of DAPR. Furthermore, we recommend that HPD expand appropriate metrics used for characterizing DAPR's effects on both the intended objectives (e.g., broadening support of first-time and early-career PIs), as well as potential unanticipated consequences, for example on the assessment of scientific return and achievement of project success.
- Inclusion plan concerns:
  - We find there is disparity in institutional resources that potential proposers can leverage to support the development of these plans. This could negatively impact potential proposers from institutions with fewer inclusion resources, especially those from states that are legislating the removal of DEI offices.
  - We find that there is a concern in the community that, if inclusion plans become part of the proposal evaluation process in the future, the resources required for the execution of the necessary (and important) inclusion efforts could come at the cost of the proposed science effort. We recommend that HPD explore whether additional resources can be made available, e.g., from the SMD level, that are dedicated to providing additional funding for inclusion plan activities on awarded grants so that the proposed science effort is not reduced by impactful inclusion efforts.



Planetary Science Advisory Committee (PAC) Report

Hope Ishii, PAC Chair

NASA Advisory Council Science Committee

virtual meeting

25 March 2024

NASA Planetary Science Advisory Committee

- PAC Executive Secretary – Ryan Watkins
- PAC Members
  - Hope Ishii, Chair – University of Hawai‘i at Mānoa
  - 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
  - Shannon Curry – University of Colorado, Boulder
  - 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

* new members in 2024

PAC Meeting Schedule and Status

PAC meeting 3x / year: spring (Feb/Mar, hybrid), summer (Jun/Jul, hybrid), winter (Nov/Dec, virtual)

2 PAC meetings since PAC last presented at a NAC Science Committee meeting

- Nov 13-14, 2023, under Serina Diniega's leadership
- Mar 4-5, 2024 with 4 new members

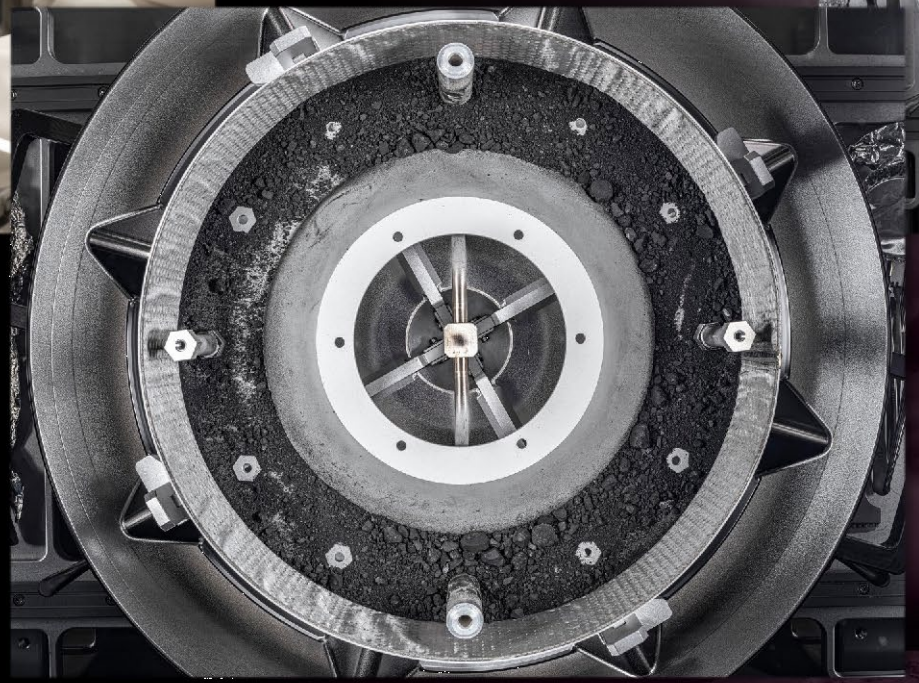
Next PAC meeting

- tentatively July 9-10, 2024

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

OSIRIS-REX: 121.6 grams!









Europa Clipper

Assembly, Test, and Launch Operations (ATLO) Progress

- All planned installations at JPL are complete
- Two of three system-level functional tests successfully completed (third in April)
- Final environmental test (System Thermal Vacuum testing) has begun and concludes in March
- First Clipper undergraduate research opportunity (Inspiring Clipper: Opportunities for Next-generation Scientists; ICONS): 39 projects and >3500 applicants
- 2,629,938 names submitted as part of the Message in a Bottle Campaign!

Spacecraft ships to KSC:
May 2024

Launch period opens:
October 2024

Jupiter Orbit Insertion: April 2030





High-Gain Antenna after radome removal in cleaning orientation

Random vibe testing (Y axis)

Juno



Io, with nightside illuminated by 'Jupitershine"

Processing: Emma Wälimäki

Recent flybys of Io (December 2023 and February 2024) at low altitude review spectacular detail

- High-resolution images in IR and visible light reveal surface changes since Galileo and Voyager visits
- Evidence of:
  - an active plume
  - Tall mountain peaks with well-defined shadows
  - Lava lakes
- First high-resolution microwave observations of Io reveal regions of lava and sulfur dioxide ice

Slide from Dr. Lori Glaze, March 2024

Peregrine (Astrobotic)



First launch of ULA's Vulcan Centaur rocket on January 8, carrying Astrobotic's Peregrine lander (Credit: Julia Bergeron)

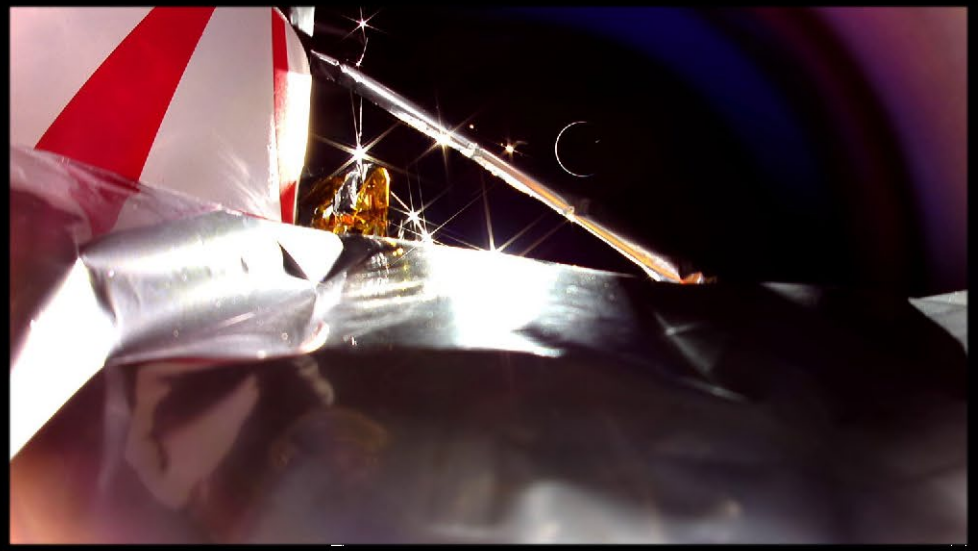


Photo of Earth, with the Sun hidden, taken from the Peregrine lander (Credit: Astrobotic)

Odysseus (Intuitive Machines)



Image captured from Odysseus shortly after separation from SpaceX second stage(Credit: Intuitive Machines)



Image captured from Odysseus on the lunar surface, taken on February 27 (Credit: Intuitive Machines)

Thanks Ingenuity!

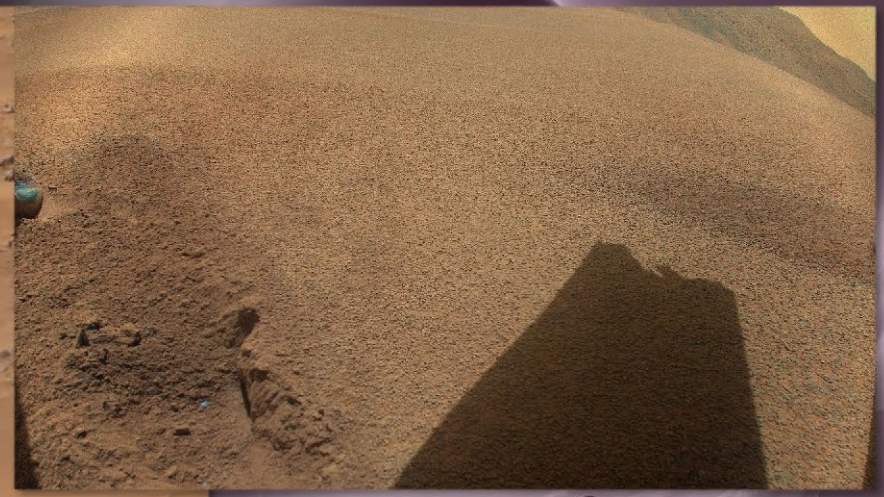


Image showing the shadow of a damaged rotorblade

Possible blade remnant and impact scar

Ingenuity's final resting spot in 'Valinor Hills'

- Last (72nd) flight was made on January 18
- Although damaged, helicopter remains upright and in communications with ground controllers

November 2023 PAC Meeting

- **Topics presented and discussed:**
  - Planetary Science Division Update
  - Planetary Science R&A Update
  - Assessment/Analysis Group (AG) Updates
  - Astrobiology Program Update
  - Research Coordination Networks (RCNs) – LIFE, NExSS
  - Mars Exploration Program Update
  - Mars Sample Return – IRB Response Planning and Updates
  - SRB Process Review
  - Mental Health in the Planetary Science Community
  - PAC GPRAMA Discussion
  - Deep Space Network (DSN) Update
  - Planetary Data Ecosystem Update
  - ESSIO/Lunar Discovery and Exploration Program
  - Integrated Lunar Science Strategy

March 2024 PAC Meeting

- **Topics presented and discussed:**
  - Planetary Science Division Update
  - Planetary Science Division R&A Update
  - Assessment/Analysis Group (AG) Updates
  - Astrobiology Program Update
  - Research Coordination Networks (RCNs) – NfoLD, PCE3
  - Mars Exploration Program Update
  - Moon to Mars Tiger Team Report
  - PDCO Interagency Deep Space Radar Study
  - EDIA for Leaders in Planetary Sciences: An Innovative Workshop
  - ESSIO/Lunar Update
  - Radioisotope Power Systems Program Update

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

Findings & Responses (abbreviated) from Nov 13-14, 2023

Highlighted Findings

- *Finding 1:* The PAC recognized that the **Standing Review Board** (SRB) is critical in mission development and appreciated efforts to improve SRB procedures and cultivate a broad and diverse pool of potential SRB members. The PAC encouraged:
  - i. SMD to provide transparency by sharing planned changes in SRB processes within public forums;
  - ii. open calls for nominations and self-nominations for potential SRB members;
  - iii. opportunities for mentoring/training on the SRB processes and roles that are appropriately open.

  Response: SMD and Agency plan to provide details of SRB plans and actions at forthcoming public forums (e.g. Townhalls, Division Advisory Committee meetings). SMD plans establish a path for greater reach (as well as training and resources) to individuals who have not previously been involved in SRBs.

- *Finding 2:* The PAC recognized the extreme challenge of decision-making in the uncertain budget environment and appreciated PSD's transparency regarding budget priorities and development of NASA's response to the MSR Indep. Review Board report. The PAC reaffirmed **support for the Origins, Worlds and Life Decadal prioritization of Mars Sample Return and the need for balance** across the planetary portfolio and community support.

  Response: PSD thanked PAC for support of MSR and balance across the portfolio and is awaiting the FY24 appropriation, FY25 President's Budget Request and results of the MSR IRB Response Team (MIRT).

Full text of PAC Findings, presentations, and meeting minutes: https://science.nasa.gov/researchers/nac/science-advisory-committees/pac/.
Full text of PDS response to Findings from the November 2023 meeting are in Dr. Glaze's presentation at the March 2024 meeting.

Findings & Responses (abbreviated) from Nov 13-14, 2023

Highlighted Findings (cont'd)

- *Finding 3:* The PAC recognized the **impact of mental health** on science products and the composition of the planetary science community, noted the importance of mental health studies like that presented to the PAC by Dr. David Trang, and recommended:
  i. any NASA workforce survey include an assessment of mental health;
  ii. NASA continue to make progress to address the OWL Decadal survey recommendation for regular workforce assessment (Chap. 16).

  Response: PSD requested clarification as to internal vs. external community surveys and noted extreme challenges of external workforce surveys by NASA. SMD continues to explore appropriate mechanisms to conduct Decadal Survey recommended workforce assessments.

- *Finding 5:* The PAC learned PSD intends to merge Emerging Worlds (EW), Solar System Workings (SSW), and Solar System Observations (SSO) programs into a **new Solar System Science (SSS) program** and discussed concerns, also raised in the Decadal Survey, around large merged programs. The PAC recommended PSD: (i) ***delay*** this merger until (A) the broad community can be informed, with rationale, and allowed to provide feedback and (B) PSD completes assessment of the No Due Date (NoDD) program...<see full Finding>

  Response: PSD decided to delay the proposed merger for ROSES-24. Assessment of NoDD will be completed to determine if it will be implemented in the proposed program merger which is tentatively planned for ROSES-25.

Full text of PAC Findings, presentations, and meeting minutes: https://science.nasa.gov/researchers/nac/science-advisory-committees/pac/.
Full text of PDS response to Findings from the November 2023 meeting are in Dr. Glaze's presentation at the March 2024 meeting.

Findings & Responses (abbreviated) from Mar 4-5, 2024

Highlighted Findings

- *Finding 1:* The PAC reaffirmed our prior finding (Nov 2023) in **strong support of the priorities and budget guidelines in the Origins, Worlds, and Life Decadal Survey** and noted the **unanimous support of the community Assessment/Analysis Groups** for Decadal priorities.
- *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 recommended a regular and ongoing pattern of 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.
- *Finding 4:* The PAC recognized 1) the critical role of the Deep Space Network in planetary science missions and radar science and 2) the substantial stress that deferred maintenance and significantly increased demand of upcoming planetary and crewed lunar missions through the Artemis Program will have on an already strained, aging infrastructure. Even with Lunar Exploration Ground Sites (LEGS) facilities and select DSN Lunar Exploration Upgrades (DLEU) underway, the **Deep Space Network's capacity is likely to be insufficient to meet the needs of both Artemis and Planetary Science**. Recognizing budgetary constraints across the Agency, the PAC requested more detailed information on the strategy for allocation of DSN resources, the Agency's strategy for mitigation, and policies for mission prioritization (US and international) directly competing for DSN resources at a given time. The PAC would also like to hear a review of the DSN Futures Final Report when it becomes available.
- *Finding 2:* The PAC thanked PSD and SMD leadership for advocacy resulting in the Administrator's certification to Congress for a limited exemption under the Wolf Amendment that allowed access by NASA-funded researchers to **Chang'e 5 lunar samples** returned by the Chinese space agency.

Full text of PAC Findings, presentations, and meeting minutes: https://science.nasa.gov/researchers/nac/science-advisory-committees/pac/.

Topics of interest for next meeting (TBD)

- PSD update
- R&A update
- AG reports

- Mars Exploration Program / Mars Sample Return
  - MSR IRB Review Team (MIRT) report and budget implications
- ESSIO/Lunar science update
  - end-to-end Artemis architecture briefing
  - LEAG-ExMAG joint Special Action Team (SAT) team briefing
  - Moon-to-Mars science planning process and update

- Astrobiology Strategy 2025 development plan

- Results of RFP on commercial services to Mars

- Cross-AG EDIA Working Group update

- DSN resource allocation, mitigation efforts, mission prioritization and DSN Futures Final Report, if available (in Finding #4)

Findings & Responses (abbreviated) from Nov 13-14, 2023

Additional Findings

- *Finding 4:* The PAC appreciated hearing about recent **reorganization of Astrobiology leadership and structuring of Research Coordination Networks (RCNs)**. The PAC recommended: (i) more concrete goals and specific pathways for achievement; (ii) metrics to assess whether the RCNs are meeting the goals of broadening community involvement; (iii) application of lessons from the NExSS assessment and sharing of plans/actions with community; and (iv) centralizing some administrative support by Astrobiology program for RCNs.
- *Finding 6:* The PAC encouraged PSD to continue to listen to the community and consider options for including **accessibility and inclusion in facility and meeting/workshop site selection**, within legal bounds and with consideration of needs of historically underrepresented groups.
- *Finding 7:* The PAC endorsed the MAPSIT/LEAG white paper supporting use of the Mean Earth (ME) over Principal Axis (PA) **lunar reference frame for mapping**.

Findings & Responses (abbreviated) from Mar 4-5, 2024

Additional Findings

- *Finding 5:* The PAC appreciates **ExoPAG**'s proactive efforts to create productive and longstanding relationships between many disciplines, including the astrophysics and planetary science communities. The PAC looks forward to the forthcoming community review paper that will identify synergies among multiple disciplines and link the science initiatives of the Astro2020 and Origins, Worlds and Life 2023 decadal surveys.

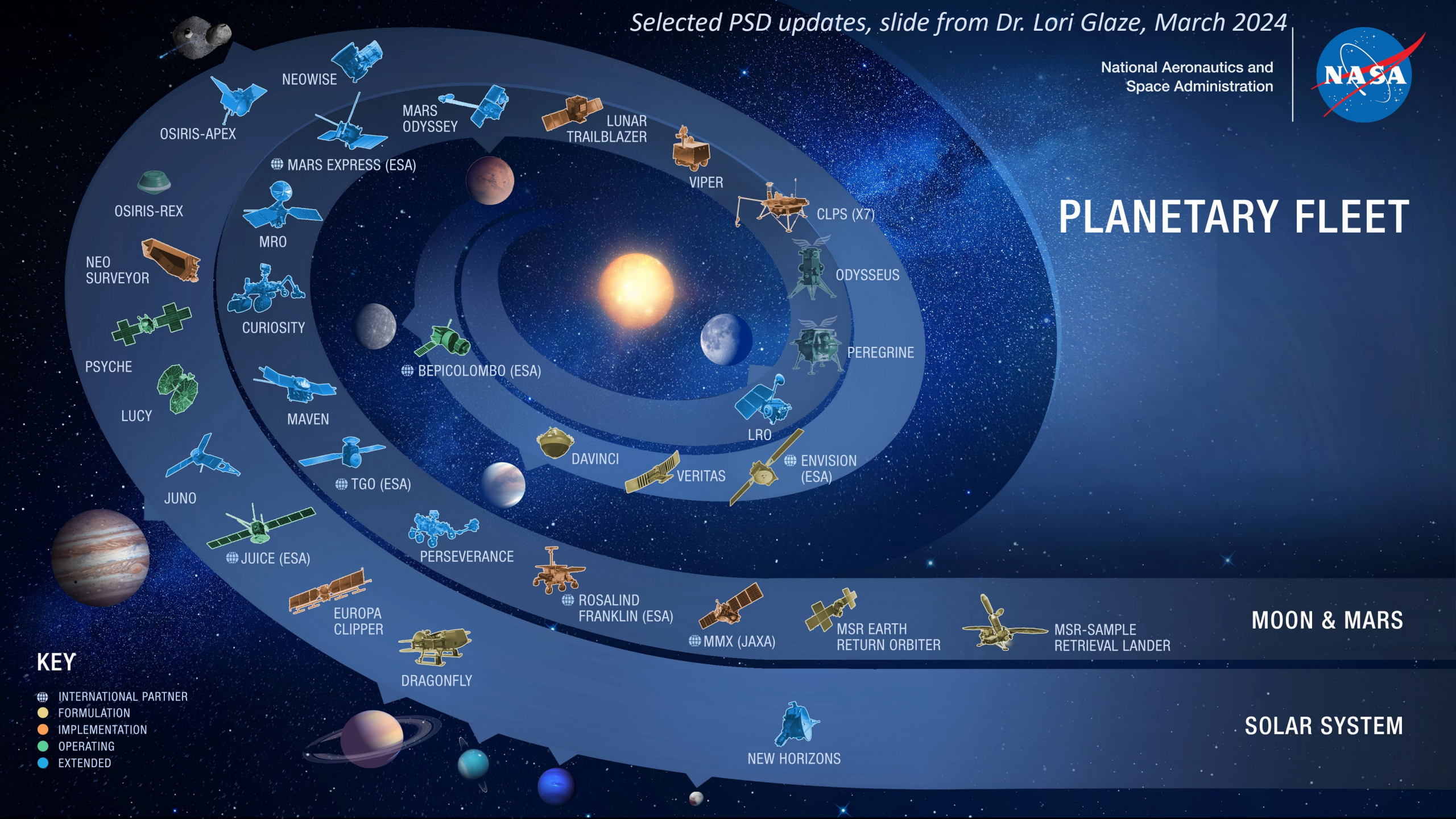
Full text of PAC Findings, presentations, and meeting minutes: https://science.nasa.gov/researchers/nac/science-advisory-committees/pac/.
Full text of PDS response to Findings from the November 2023 meeting are in Dr. Glaze's presentation at the March 2024 meeting.

Selected PSD updates, slide from Dr. Lori Glaze, March 2024

National Aeronautics and Space Administration

NASA

PLANETARY FLEET



MOON & MARS

SOLAR SYSTEM

KEY

- INTERNATIONAL PARTNER
- FORMULATION
- IMPLEMENTATION
- OPERATING
- EXTENDED