National Aeronautics and Space Administration

NAC SCIENCE COMMITTEE SUMMER MEETING 2023

NAC Science Committee Agenda
Tuesday, August 29, 2023

• 8:00-9:00am	Non-FACA Session: Annual Ethics Training	All Members Required
• 9:00-9:05	Break to switch to Public Session	
• 9:05-9:10	Call to Order	Nathan Boll
• 9:10-9:15	Introduction of Members/Summary of Activities	Ellen Williams
• 9:15-10:15	SMD Update	Sandra Connelly
• 10:15-10:30	Break to bring in panelists	
• 10:30-12:00pm	Deep Space Network Panel Discussion	Philip Baldwin Suzanne Dodd Sandra Cauffman
• 12:00-1:00	Lunch	
• 1:00-2:00	Committee Discussion	
• 2:00	Adjourn	
• 2:30-4:30	JPL Tour and Escort to Visitor Center	
• 5:00	Depart JPL Visitor Center	
• 6:00-7:30	Group Dinner	

NAC Science Committee Summer Meeting 2023

Dr. Ellen Williams

Chair, NAC Science Committee

Hear updates, deliberate, and formulate any needed advice on:

Day 1

- **SMD Update** – Receive an update from SMD Deputy Associate Administrator, Sandra Connelly
- **Deep Space Network** – Follow-on panel discussion to address:
  - SCaN Organization, Context & Challenges
  - DSN status and future planning
  - An update on SMD needs presented at the Spring Meeting

Day 2

- **NASA SMD Initiatives to Lower the Boundaries to Science Research**
  - A panel discussion that will highlight a sample of initiatives from across SMD that enable and empower everyone to experience and participate in science
- **Heliophysics Big Year** – the Public Lecture will focus on the upcoming global celebration of solar science staring October 2023 and ending December 2024.
- **Any topics raised by the DAC Chairs that would benefit from SC attention**

Report the results of our meeting and any other insights to SMD Associate Administrator Nicky Fox in our Outbrief

National Aeronautics and Space Administration

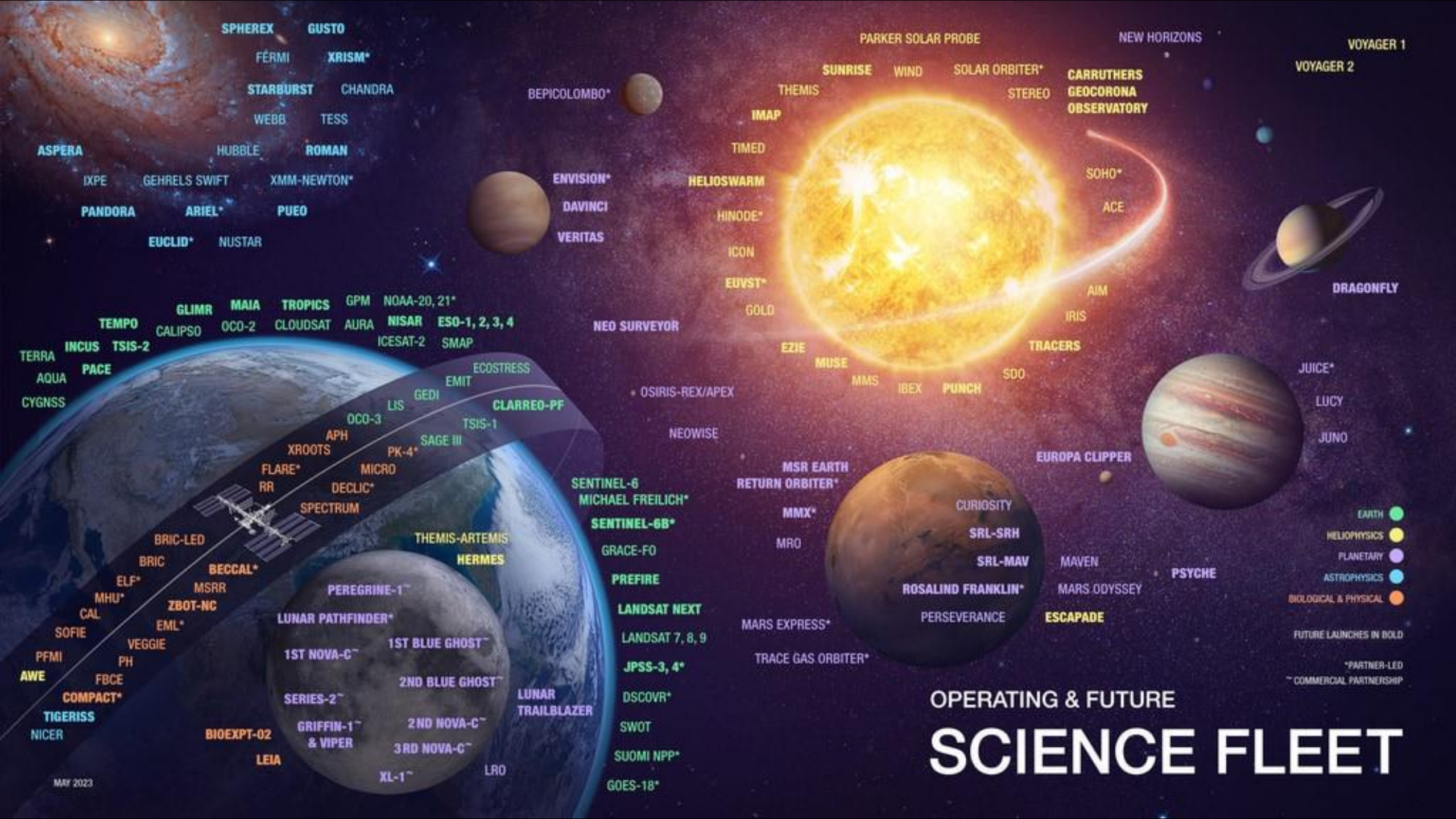
Inspired Science: Powered by NASA

Sandra Connelly

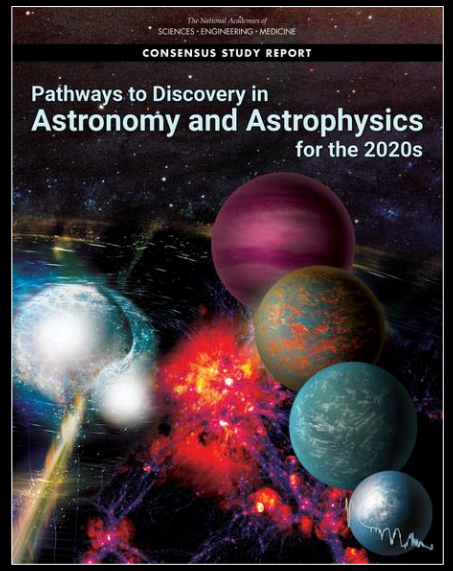
Deputy Associate Administrator,
Science Mission Directorate

NASA Advisory Council – Science Committee

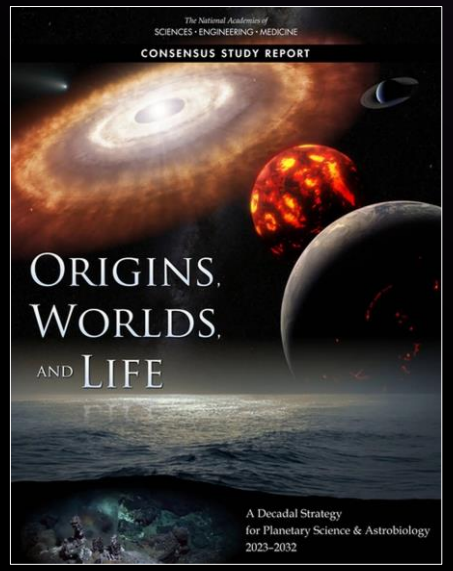
August 29, 2023


SPHEREX
GUSTO
FERMI
XRISM*
STARBURST
CHANDRA
WEBB
TESS
ASPERA
HUBBLE
ROMAN
IXPE
GEHRELS SWIFT
XMM-NEWTON*
PANDORA
ARIEL*
PUEO
EUCLID*
NUSTAR
BEPICOLOMBO*
ENVISION*
DAVINCI
VERITAS
PARKER SOLAR PROBE
NEW HORIZONS
VOYAGER 1
VOYAGER 2
SUNRISE
WIND
SOLAR ORBITER*
CARRUTHERS GEOCORONA OBSERVATORY
THEMIS
STEREO
IMAP
TIMED
HELIOSWARM
HINODE*
ICON
EUVST*
GOLD
NEO SURVEYOR
SOHO*
ACE
AIM
IRIS
TRACERS
EZIE
MUSE
MMS
IBEX
PUNCH
SDO
OSIRIS-REX/APEX
NEOWISE
DRAGONFLY
JUICE*
LUCY
JUNO
EUROPA CLIPPER
GLIMR
MAIA
TROPICS
GPM
NOAA-20, 21*
TEMPO
CALIPSO
OCO-2
CLOUDSAT
AURA
NISAR
ESO-1, 2, 3, 4
INCUS
TSIS-2
ICESAT-2
SMAP
TERRA
PACE
AQUA
CYGNSS
ECOSTRESS
EMIT
GEDI
LIS
CLARREO-PF
OCO-3
TSIS-1
APH
SAGE III
XROOTS
PK-4*
FLARE*
MICRO
RR
DECLIC*
SPECTRUM
BRIC-LED
BRIC
BECCAL*
ELF*
MSRR
MHU*
ZBOT-NC
CAL
EML*
SOFIE
VEGGIE
PFMI
PH
AWE
FBCE
COMPACT*
TIGERISS
NICER
BIOEXPT-02
LEIA
PEREGRINE-1~
LUNAR PATHFINDER*
1ST BLUE GHOST~
1ST NOVA-C~
2ND BLUE GHOST~
SERIES-2~
GRIFFIN-1~ & VIPER
2ND NOVA-C~
3RD NOVA-C~
XL-1~
LRO
LUNAR TRAILBLAZER
THEMIS-ARTEMIS
HERMES
SENTINEL-6 MICHAEL FREILICH*
SENTINEL-6B*
GRACE-FO
PREFIRE
LANDSAT NEXT
LANDSAT 7, 8, 9
JPSS-3, 4*
DSCOVR*
SWOT
SUOMI NPP*
GOES-18*
MSR EARTH RETURN ORBITER*
MMX*
MRO
MARS EXPRESS*
TRACE GAS ORBITER*
CURIOSITY
SRL-SRH
SRL-MAV
ROSALIND FRANKLIN*
PERSEVERANCE
MAVEN
MARS ODYSSEY
ESCAPADE
PSYCHE
EARTH
HELIOPHYSICS
PLANETARY
ASTROPHYSICS
BIOLOGICAL & PHYSICAL
FUTURE LAUNCHES IN BOLD
*PARTNER-LED
~ COMMERCIAL PARTNERSHIP
MAY 2023
OPERATING & FUTURE
SCIENCE FLEET

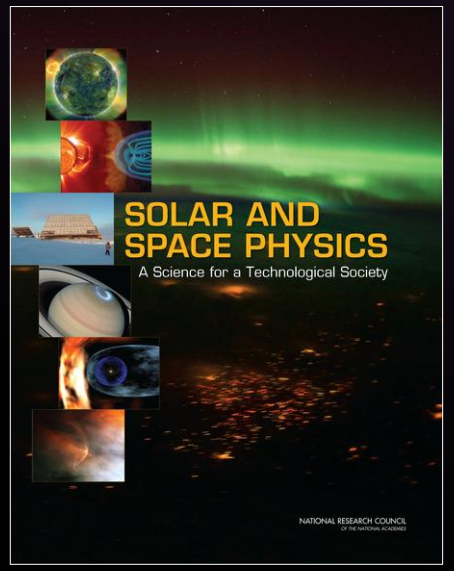
Decadal Surveys Drive Requirements



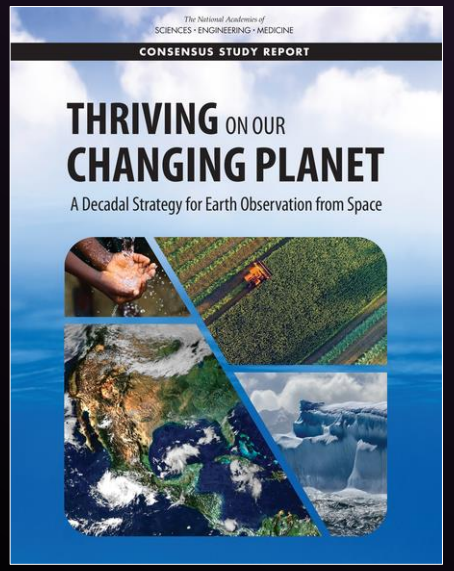
ASTROPHYSICS



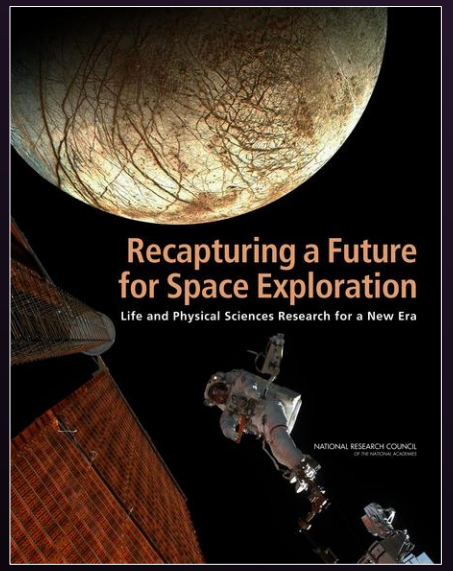
PLANETARY



HELIOPHYSICS



EARTH



BIOLOGICAL AND
PHYSICAL SCIENCES

Dr. Lisa Carnell

Division Director
Biological & Physical Sciences Division

- Recently served as BPS's Program Scientist for Translational Research
- Led strategic partnership initiatives with other government agencies, including NIH, BARDA, FDA, DARPA, NSF, and the USDA
- Holds a PhD from Duke University
- Formerly served as the Space Radiation Medical Countermeasure Lead for NASA's Human Research Program
- Extensive background in understanding and mitigating radiation-induced health effects on humans

Dr. David Grinspoon

Senior Scientist
Astrobiology Strategy (SSAS)

- Dr. Grinspoon’s papers have been published in Nature, Science, and numerous other journals
- Frequently gives talks to all levels of audiences around the world
- Received awards for innovative ways of teaching astrobiology to both undergraduates and graduates at multiple universities
- Participated in numerous NASA-related strategic planning and advisory roles
- Currently serving on the Unidentified Anomalous Phenomena Independent Study Team

Recent Launches

Tropospheric Emissions: Monitoring of Pollution (TEMPO)

April 7, 2023

Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats (TROPICS)

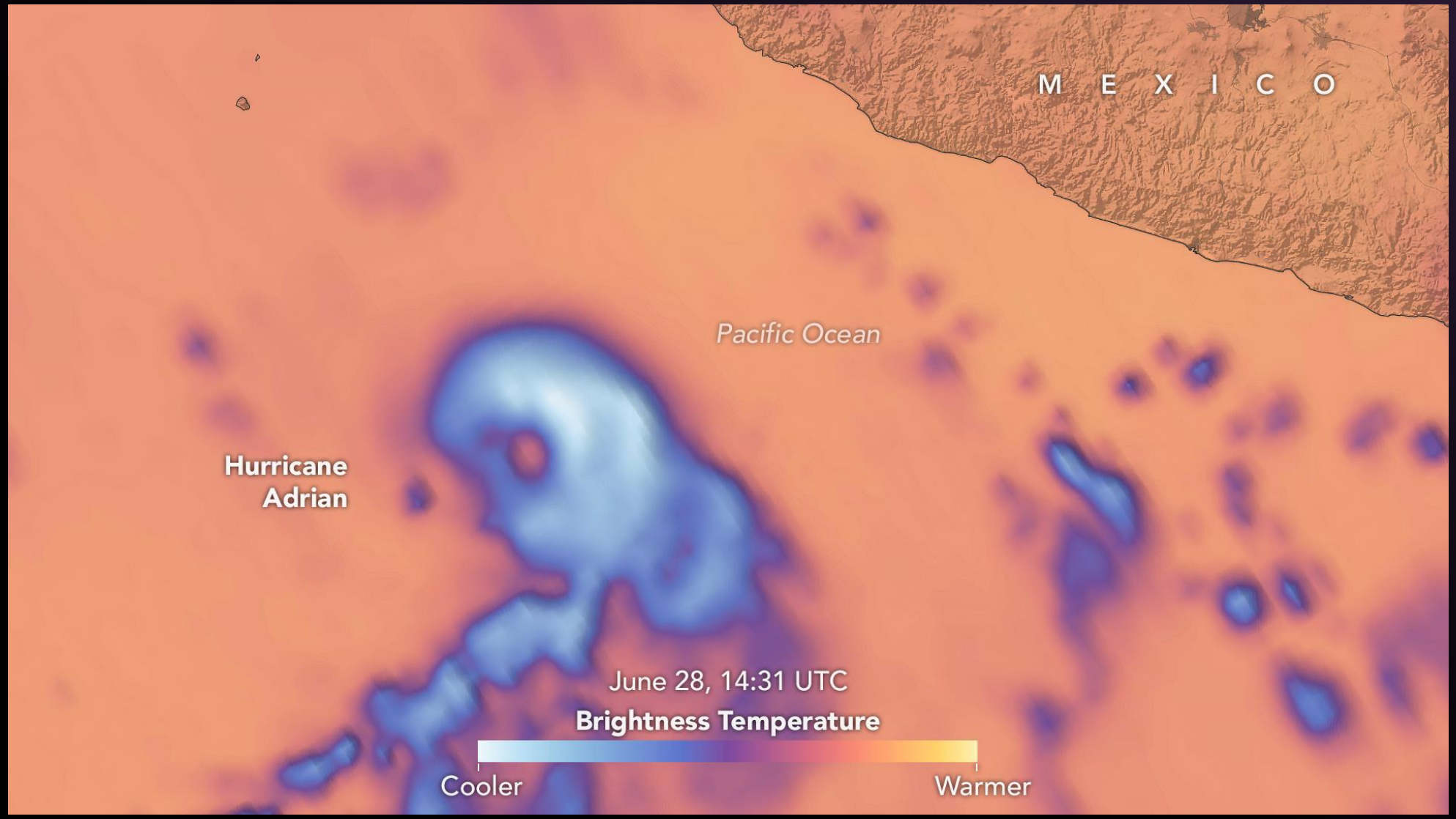
May 8, 2023

May 26, 2023

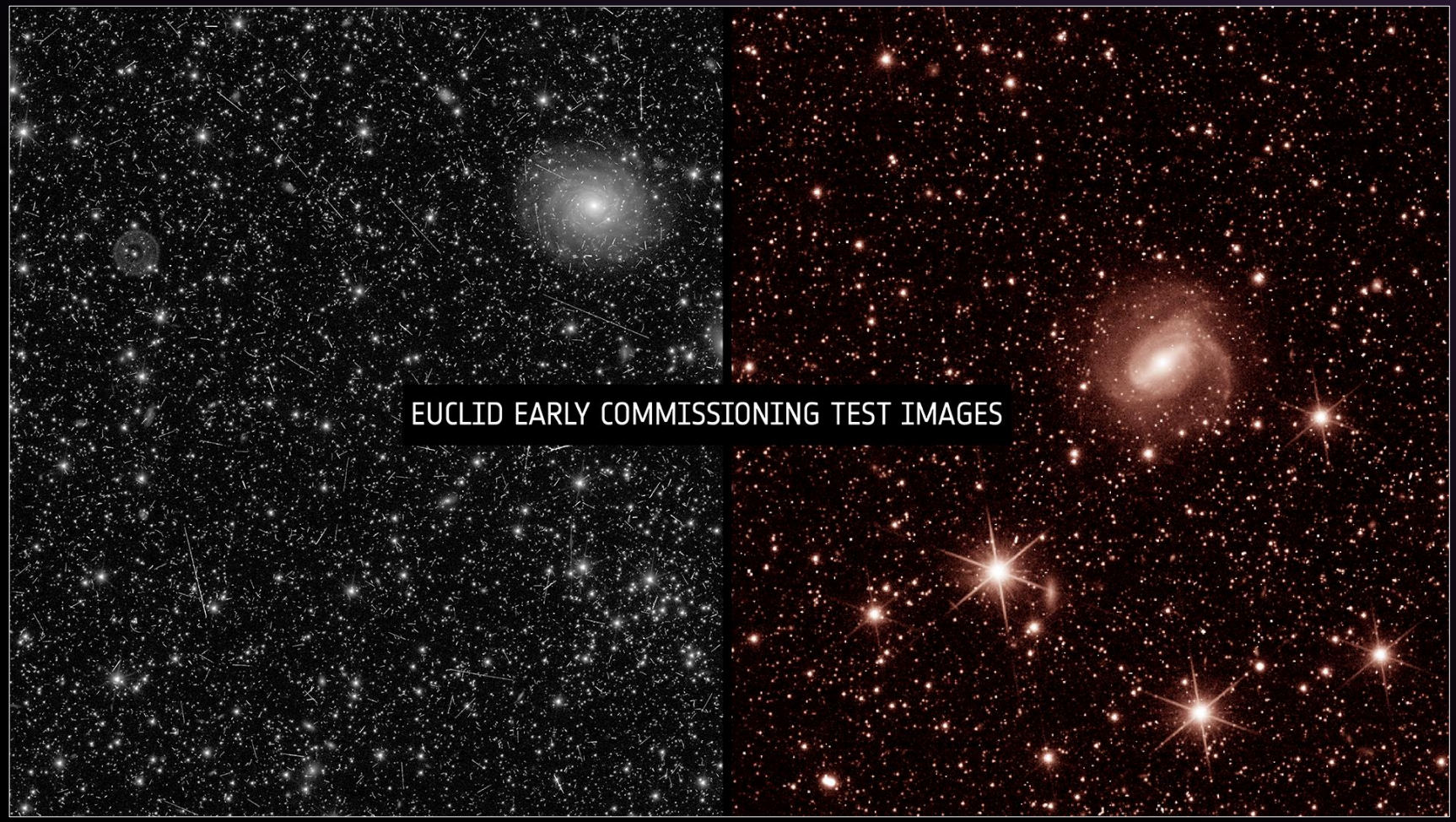
A SpaceX Falcon 9 rocket lifts off from Cape Canaveral Space Force Station in Florida at 11:12 a.m. EDT on Saturday, July 1, carrying the ESA (European Space Agency) Euclid spacecraft, which has contributions from NASA

July 1, 2023

TROPICS FIRST LIGHT



EUCLID First Light Imagery



Test Images from Euclid's two instruments captured on July 31, 2023

JWST image of the Rho Ophiuchi cloud complex
released in commemoration of JWST one year in orbit

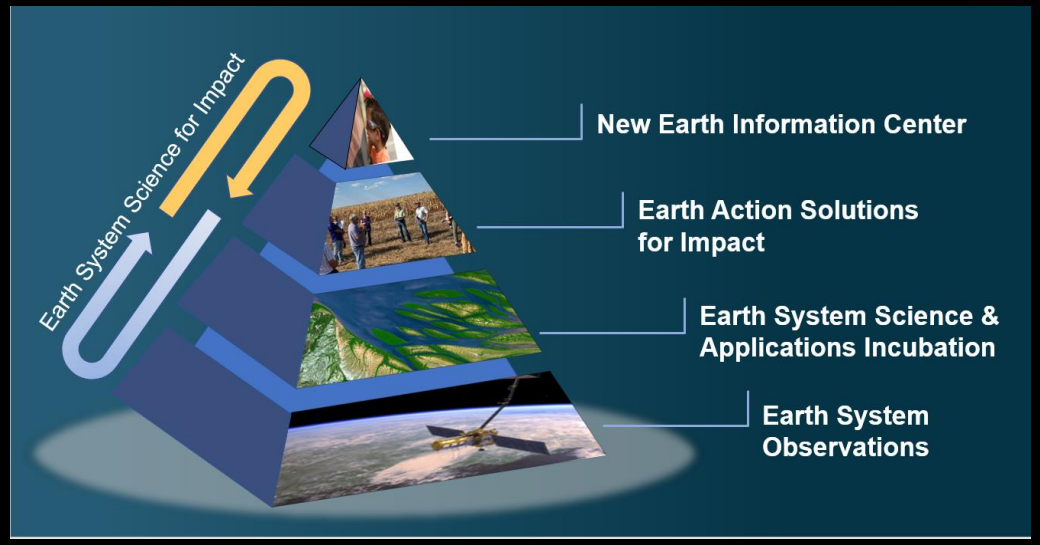
XRISM

The X-ray Imaging and Spectroscopy Mission (XRISM) spacecraft as it appeared in May at Tsukuba Space Center, Japan. The open compartment near the bottom houses its Goddard-developed Resolve instrument. XRISM's original launch window has been delayed due to weather but will take place in September 2023. ***Credit:*** *JAXA/NEC*

Earth Information Center

A physical and virtual space to engage and amplify impact – ***to show people our Earth as we see it***.

- This center showcases large, awe-inspiring visualizations, as well as interactive media, stories, and narratives to inspire action. The intent is to stimulate communities to explore solutions and provide opportunities for connecting science to action



An observer watching real-time data collection in the newly opened Earth Information Center at NASA HQ

Take a virtual tour of the EIC here: Earth Information Center (nasa.gov)

Earth Information Center

NASA Earth Science Division Director Karen St. Germain, far right, talks with Prime Minister Oyun-Erdene Luvsannamsrai of Mongolia, as they along with NASA Deputy Administrator Pam Melroy tour NASA's Earth Information Center, Friday, Aug. 4, 2023, at the NASA Headquarters Mary W. Jackson Building in Washington.

BPS-USDA Plant Research at EPCOT

MICROBIAL MAGIC AT WORK

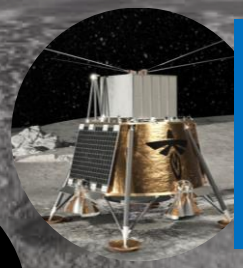
Plant growing chambers visible at the USDA Biotechnology Lab (Credit: Mark Sperry/USDA Agricultural Research Service)

CLPS Deliveries 2023-2027

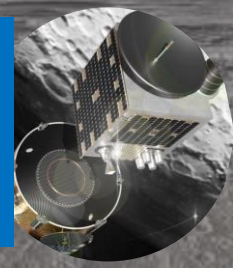
Delivery Site:
Gruithuisen Domes
Provider TBD
CP-21 | 2026

Delivery Site:
Reiner Gamma
Provider: IM
CP-11 | Apr 2024

Delivery Site:
Sinus Viscositatis
Provider: Astrobotic
TO2-AB | NLT 2023

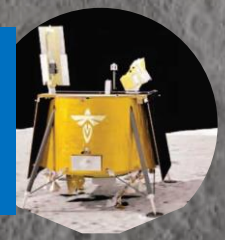


Delivery Site:
Lunar Far Side &
Orbit Insertion
Provider: Firefly
CS-3 | 2025



Delivery Site:
Ina Irregular Mare Patch
Provider: TBD
CP-32 | Q2 2027

Delivery Site:
Mare Crisium
Provider: Firefly
TO19D | 2024

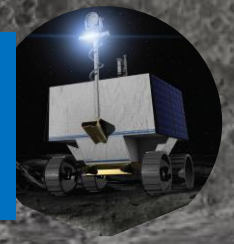


Delivery Site:
Shackleton Connecting Ridge
Provider: IM
TO PRIME-1 | Nov 2023

Delivery Site: Malapert A
Provider: Intuitive
Machines (IM)
TO2-IM | NET Q3 2023

Delivery Site:
South Pole Region
Provider TBD
CP-22 | 2026

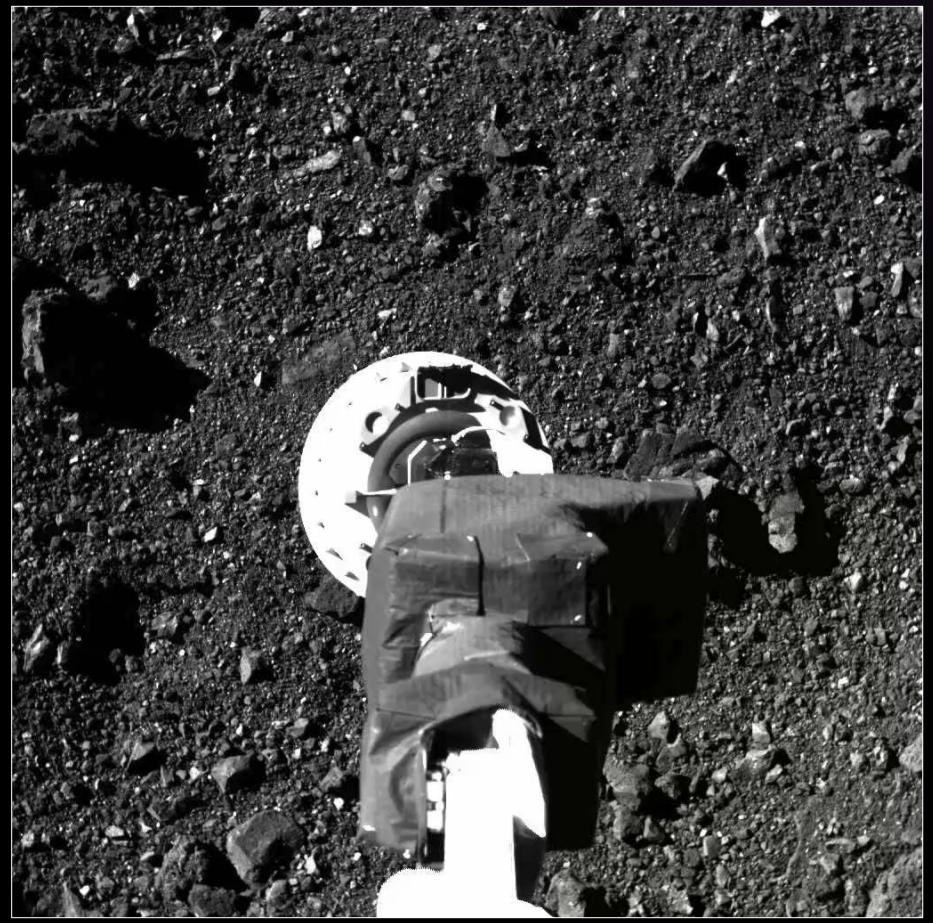
Delivery Site:
Mons Mouton
Provider : Astrobotic
VIPER | Nov 2024



Updated 7/15/2023

Asteroid Autumn

OSIRIS-REx



PSYCHE

22

Heliophysics Big Year

Solar Eclipses Across North America:

- Oct. 14, 2023: Annular
- April 8, 2024: Total

Solar Cycle 25:

- Solar maximum increases opportunities to experience and observe space weather

Parker Solar Probe:

- Parker will make its closest approach to the Sun in Dec. 2024

DSN and SMD

- SMD and SOMD are working in partnership to continue to provide the United States and the world exceptional scientific data.
- SMD, ESDMD and STMD can't do their extraordinary work without SOMD/SCaN support and talents.
- Deep space science and exploration and lunar activities (Artemis, commercial, international) are already creating significant demands on the networks –particularly the DSN –and this demand is only expected to increase.
- Both augmentation/expansion of assets as well as maintenance and sustainment of existing assets pose a challenge to the Agency.
- ESDMD, SOMD, STMD and SMD are working together to address these challenges but Agency and national leadership support are required to fully address underlying resource constraints and priorities that affect DSN infrastructure, availability and bandwidth.

DSS-14 antenna at the Goldstone Deep Space Communications Complex in Barstow, California

Message in a Bottle

- June 1st 2023, Europa Clipper launched NASA's next "Send Your Name" public engagement campaign, called Message in a Bottle.
- NASA's Message in a Bottle campaign is a special collaboration, uniting art and science, by NASA, the U.S. Poet Laureate and the Library of Congress.
- Participant's names and a poem written by the U.S. Poet Laureate will be engraved onto a chip and mounted on NASA's Europa Clipper spacecraft and travel 1.8 billion miles on its voyage to the Jupiter system.
- The poem connects two water worlds - Earth and Europa, a moon of Jupiter believed to contain a vast ocean.
- To participate please visit go.nasa.gov/MessageInABottle

From left to right: Librarian of Congress Carla Hayden, U.S. Poet Laurate Ada Limon, NASA SMD AA Dr. Nicky Fox, and Library of Congress Chair for Astrobiology Dr. Sheri Wells-Jensen held a discussion on stage at the Library of Congress during the June 2023 unveiling of Europa Clipper poem.

A Tri-Agency Dashboard


EXPLORE
With Us

NASA Advisory Committee
Science Committee
Summer Meeting
Aug 2023

Will Resume Soon

National Aeronautics and Space Administration

Deep Space Network (DSN) Panel Discussion at the NASA Advisory Council (NAC) Science Committee (SC) Meeting

August 29, 2023

Opening Remarks: SCaN Organization, Context & Challenges

Philip Baldwin

NASA SCaN Network Services Division Director (acting)

SCaN's Role at NASA

1. Develop, operate and manage all NASA space communications capabilities
2. Develop technologies to enable and enhance future mission experience
3. Manage NASA spectrum; represent NASA on national and international spectrum management forums
4. Develop space communication standards as well as positioning, navigation, and timing policies
5. Represent and negotiate on behalf of NASA on all matters related to space communications and navigation



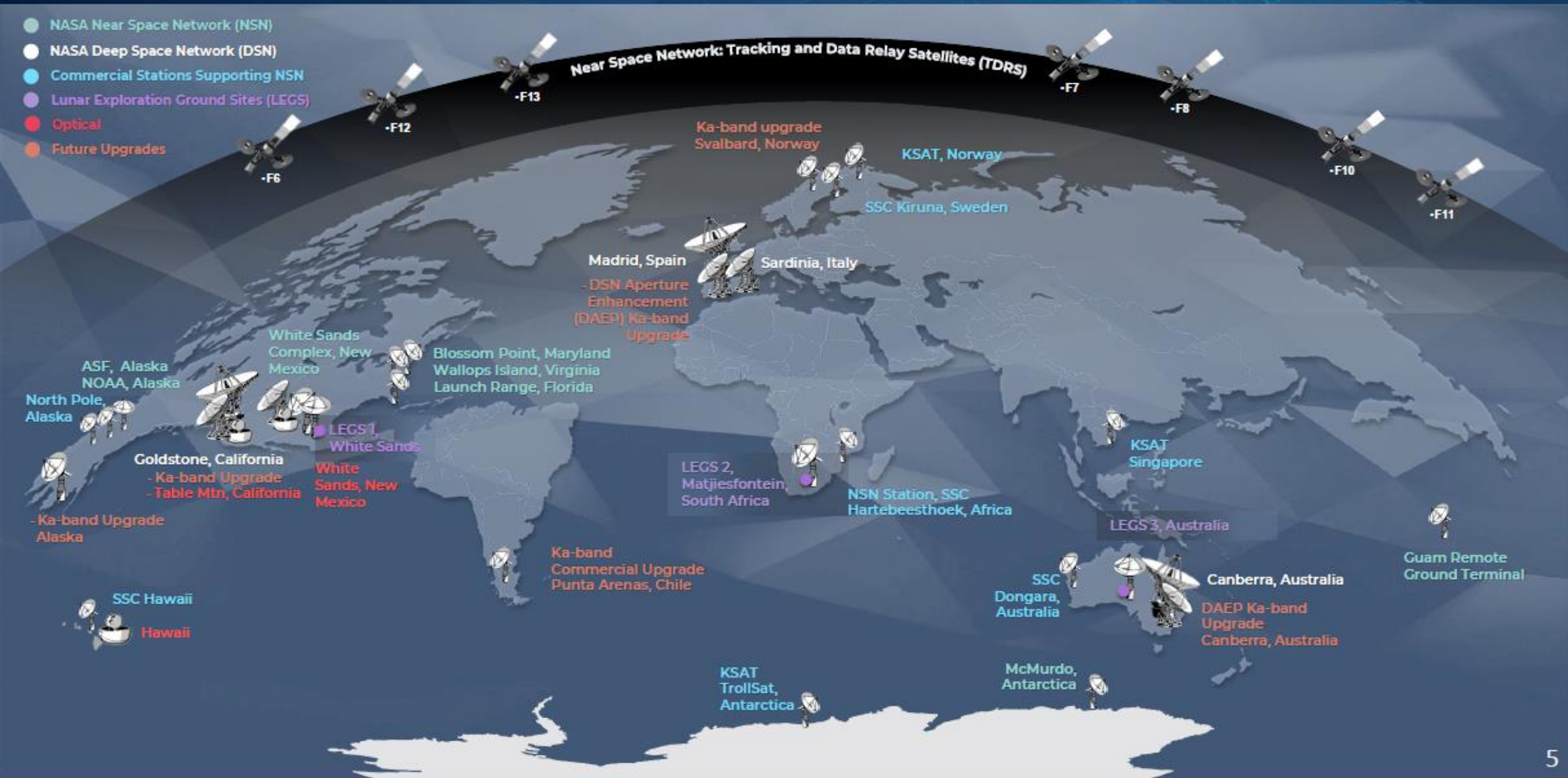


Space Communications and Navigation (SCaN) serves as the Program Office for all of NASA's space communications activities

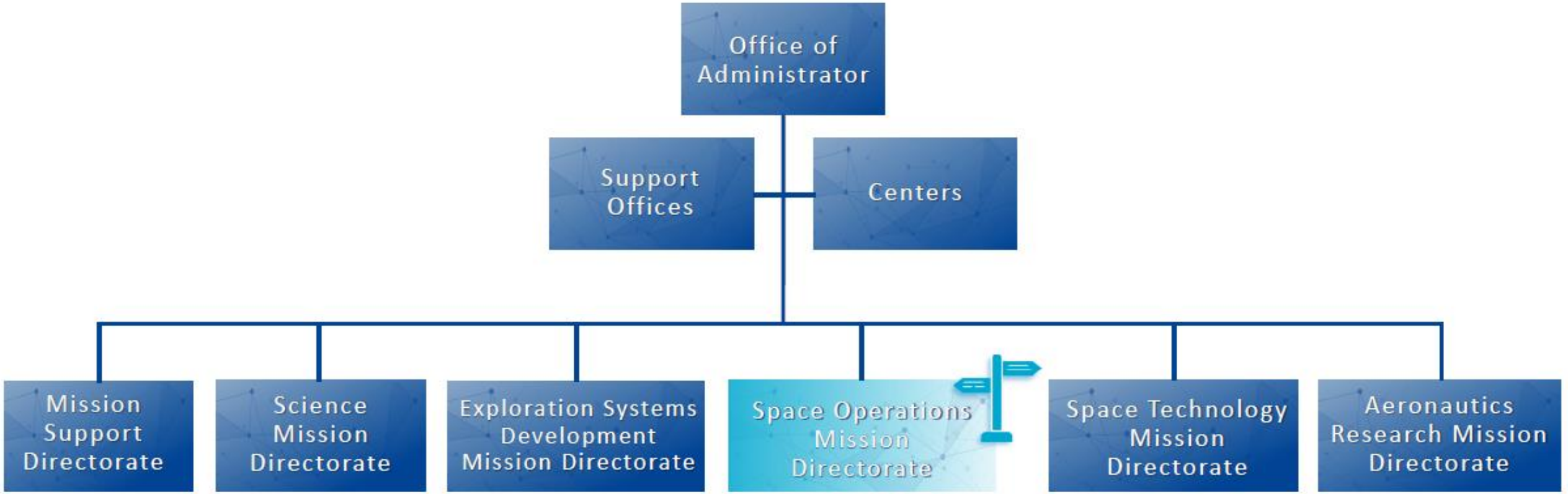
24/7 Global Near Earth and Deep Space Communications and Navigation Services

100+ Missions currently supported by SCaN

NASA's Communications Networks



Organizational Context – **SCaN within NASA**



Acting DAA: Jeff Volosin

SCaN sits within the Space Operations Mission Directorate

Major **Initiatives**

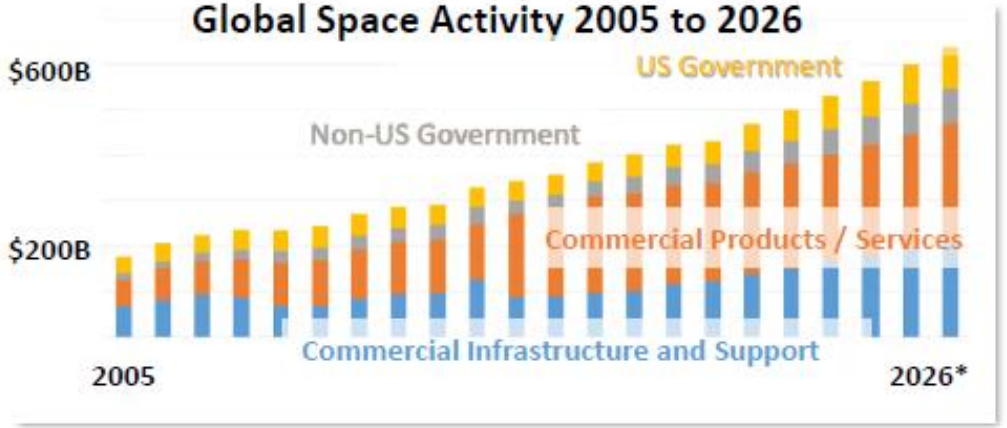
Fundamental shifts have occurred in the space sector, shaping NASA and SCaN activities

Commercialization

- 5,582+ space-focused companies in US and more than 10,000 globally with a combined value of over $4T
- OMB and National Space Policy are major drivers for NASA SCaN's shift to commercial services

Return to the Moon to stay

- NASA and International partners have committed to return to the Moon, leveraging commercial industry
- Cadence and complexity represent a new level of network demand not seen in decades



ARTEMIS

Progress in **Pursuing Commercial Services**

- Commercial Geosynchronous Orbit (GEO) **L-band** relay network — inmarsat
- **Optical** Low Earth Orbit (LEO) network — amazon | project kuiper
- GEO **C-band** and Medium Earth Orbit (MEO) **Ka-band networks** — SES GOVERNMENT SOLUTIONS
- **Optical** LEO network — SPACEX
- RF relay networks offering **C-band and Ka-band** services for high — TELESAT
- GEO **Ka-band** relay network — Viasat

Communications Services Project (CSP)

June 2022, six NASA CSP Funded Space Act Agreement awards were made totaling $278.5 million

- To test how commercial satellites in both low Earth orbit and geostationary orbit could support missions that currently use the Tracking and Data Relay Satellites (TDRS) constellation of NASA-owned spacecraft

Direct-to-Earth Communications Expansion

- Tapping into a growing market of commercial Direct to Earth (DTE) commercial vendors. As of 2022, 63% of all DTE Services NASA missions are commercially provided.
  - Request for Proposals (RFP) released in 2023 with goal to expand level of commercial services to near 100%.

SCaN's Four Point Plan for Artemis Support

Deep Space Network (DSN) Lunar Exploration Upgrades (DLEU)

1

- Upgrades to Six Deep Space Network (DSN) antennas (Two at each of the three complexes)
- Simultaneous operations – S+Ka-band or X+Ka-band, simultaneous Ka-band
- Increased data rates – greater than 100Mbps downlink in Ka-band

Lunar Exploration Ground Segment (LEGS) (18-Meter Class Antenna Subnet)

2

- A dedicated new set of antennas, designed to support lunar missions, to help alleviate the user load on the DSN
- Minimum of three sites around the Earth for continuous coverage
- NASA pursuing build of LEGS sites #1-3
- Commercial services to add additional capacity – add assets as demand grows and to meet redundancy / resiliency needs

Lunar Communications and Navigation Relay Services

3

- Removes DTE line-of-sight comm constraint & reduces user burden
- Initial relay deployment targeted at South Pole and Far-Side
- Networking and PNT services
- Commercial service procurement approach for the relay

International Partnerships and Contributions

4

- SCaN seeking contributions for both Earth based and Lunar C&N assets
- Priority 1: Direct-to-Earth assets that meet or exceed LEGS performance
- Priority 2: Lunar relay comm and PNT services
- Priority 3: Lunar surface comm and PNT capabilities

Challenges

Artemis I lessons serve to highlight the challenges the DSN will continue to face

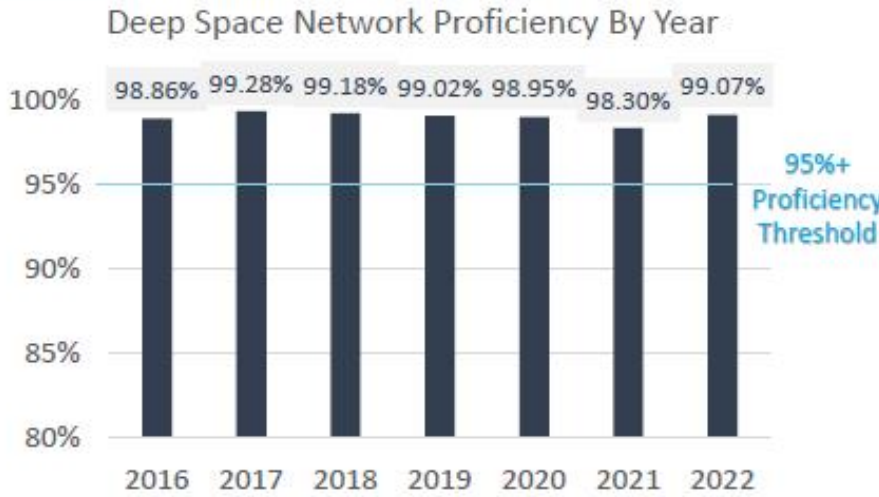
- Services were limited and subject to contention with other missions
  - > Orion designed for 24x7 DSN support
  - > Artemis I launch date impacted by resource constraints (DART mission)
- Need for more capacity and adjustment of staffing to accommodate human spaceflight CONOPS which are less automated

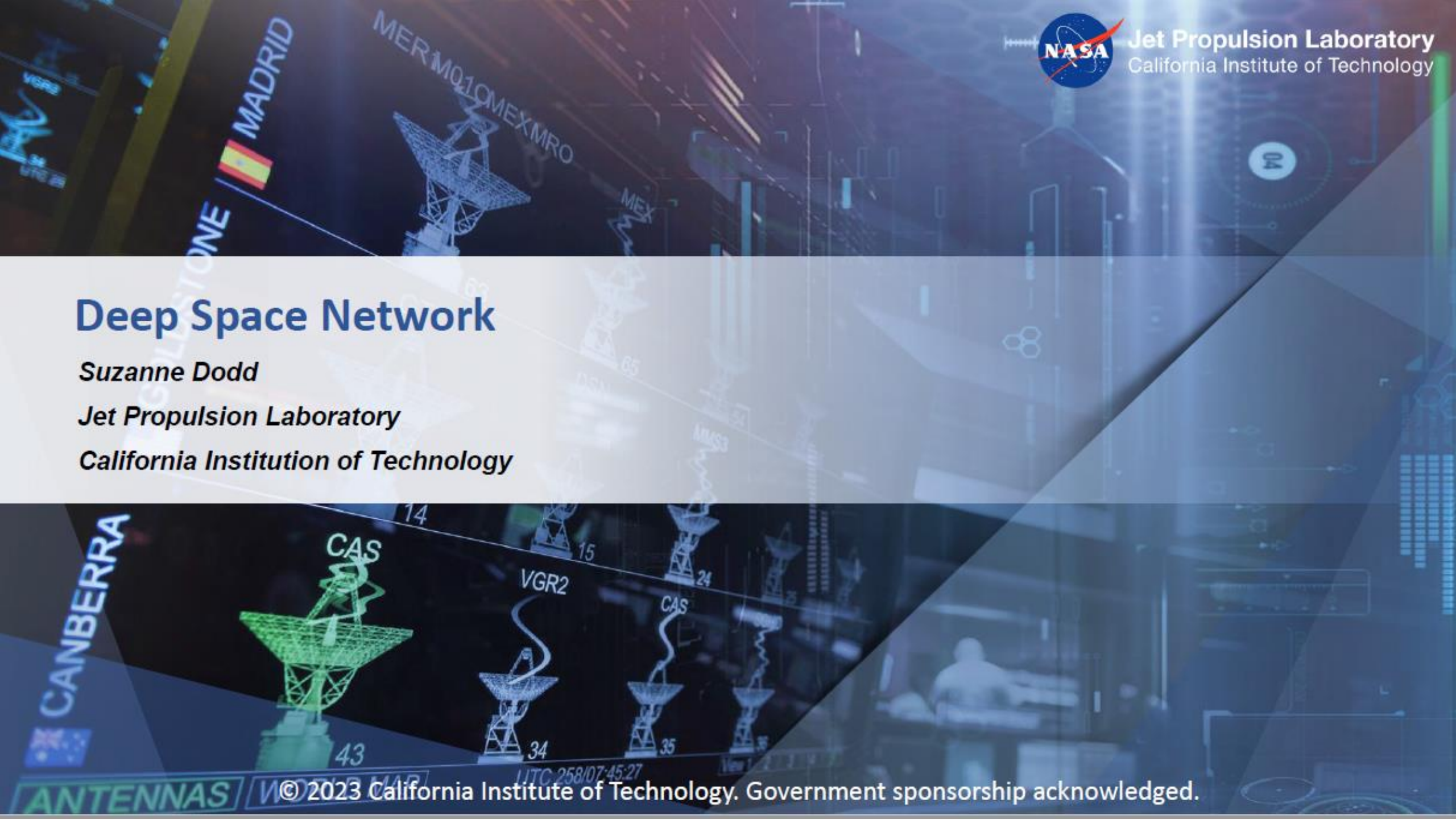
Maintaining infrastructure is an ongoing challenge

- Made more difficult by the performance success of the network – *how can it be that bad, if the network proficiency is that good?*
- Doing more with less – externalities like inflation and supply chain constraints that NASA can't control

SCaN and the DSN continually look for practical ways to improve beyond the higher-cost infrastructure items

- Enhancing operational techniques, e.g., Delay Tolerant Networking, multiple uplinks per aperture
- Equipping existing antennas with more frequencies to minimize shortages
- Encouraging missions to move to higher frequencies that are less congested





Deep Space Network

Suzanne Dodd

Jet Propulsion Laboratory

California Institution of Technology

The Global **Deep Space Network**

Canberra, Australia (CDSCC)

Control Center at JPL
Pasadena, California

Madrid, Spain (MDSCC)

Goldstone, California (GDSCC)

The DSN Makes These Missions Possible

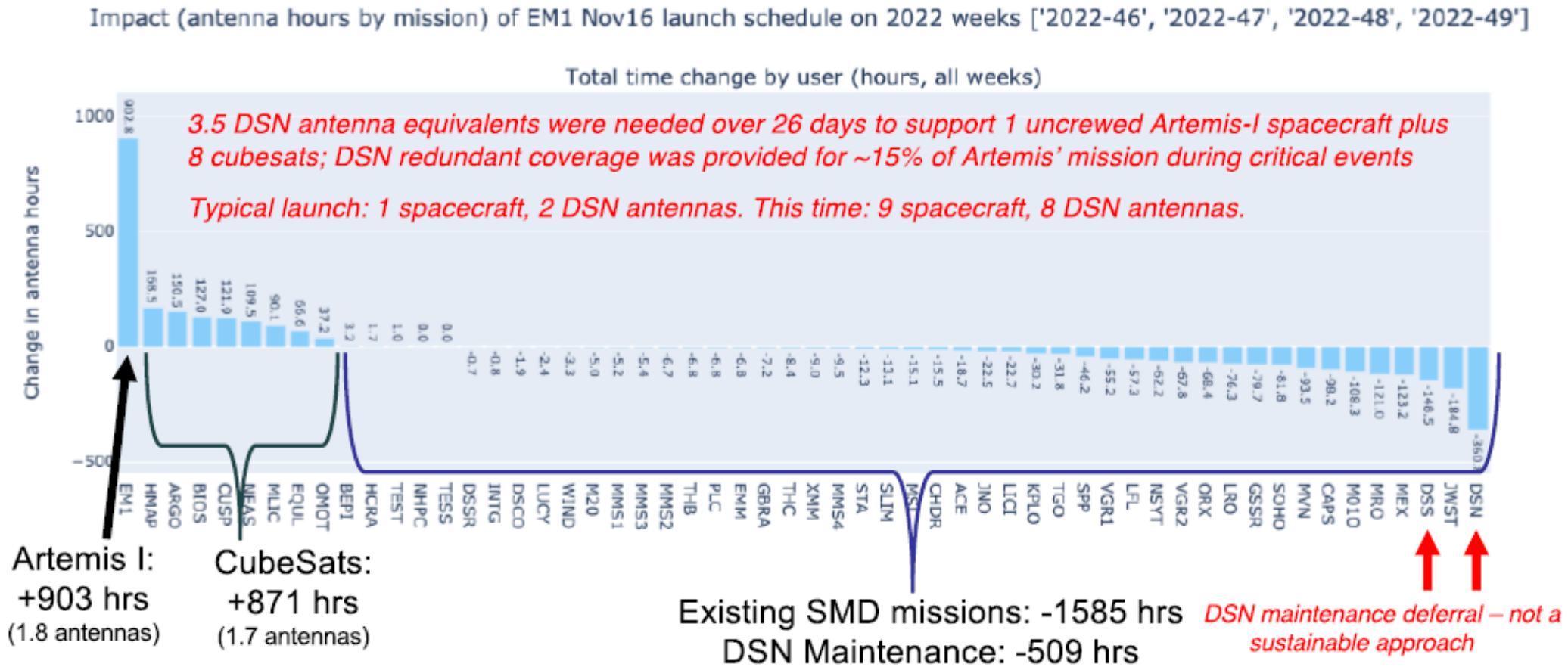
Mission Load on the DSN is Growing Rapidly

DSN Missions Dashboard for August 2023 (*Changes Monthly -- Contact S. Asmar*)					
	Completed Since 2019	Current (count: 40) Deep Space	Current (count: 40) Lunar, Lagrange, Near Sp	Future (count: 42+) Deep Space	Future (count: 42+) Lunar, Lagrange, Near Sp.
1	InSight	Juno	Lunar Recon. Orbiter	Psyche *(L 2023)*	SunRISE
2	DART	Lucy	SOHO	VERITAS *Venus*	GOES U (19)
3	GOES T	Perseverance	ACE	DAVINCI+ *Venus*	Roman Space Telescope
4	Geotail	Mars Odyssey	Wind	Dragonfly *Titan*	SWFO *Helio L1 rideshare*
5	Artemis 1	Mars Recon. Orbiter	MMS 1	Europa Clipper *(L 2024)*	Astrobotic Peregrine *Lunar*
6	NEA Scout *secondary*	MAVEN	MMS 2	Janus A (Serenity) *in storage*	Astrobotic Griffin *Lunar*
7	CuSP *secondary*	Curiosity	MMS 3	Janus B (Mayhem) *in storage*	Lunar Node-1 CLPS *Lunar*
8	LunaHMAP *secondary*	New Horizons	MMS 4	ESCAPADE Blue *Mars*	Lunar Trail Blazer *Lunar*
9	Lunar Ice Cube *secondary*	OSIRIS-REx	Themis B	ESCAPADE Gold *Mars*	IMAP *Lunar*
10	Team Miles *secondary*	Parker Solar Probe *Helio*	Themis C	Sample Return Lander *Mars*	Carruthers Lunar
11	ArgoMoon (ASI) *secondary*	Voyager 1 *Helio*	DSCOVR	Earth Return Orbiter (ESA)	VIPER *Lunar*
12	Omotenashi (JAXA) *secondar*	Voyager 2 *Helio*	Chandra	Rosalind Franklin (ESA)	Artemis-2 Orion
13	Equuleus (JAXA) *secondary*	STEREO A *Helio*	JWST	EnVision (ESA) *Venus*	Artemis-3 Orion
14	INTEGRAL (ESA)	Akatsuki (JAXA)	TESS	HERA (ESA) *Asteroid*	Exploration Upper Stage
15	Hayabusa-2 Prime (JAXA)	BepiColombo (ESA)	CAPSTONE	DESTINY+ (JAXA)	Gateway
16	LICIA Cube (ASI) *DART*	Hope, EMM (UAE)	TDRS 6-13 *emergency*	Hayabusa-2 Extend. (JAXA)	Human Landing Sys 1
17	Chandrayaan 2 Orb. (ISRO)	Trace Gas Orbiter (ESA)	Biosentinel *secondary*	MMX (JAXA) *(L 2024) Mars*	Human Landing Sys 2
18	Chandrayaan 2 Land. (ISRO)	Mars Express (ESA)	Lunar Flash Light *secondary*	Rocket Lab Venus *(commercial*	Human Landing Sys 3
19	SpaceIL Beresheet (Israel)		XMM (ESA)	Emiratres Asteroid (UAE)	Blue Origin Mark-1 SN-1
20			Gaia (ESA)		Blue Origin Mark-1 SN-2
21			KPLO (KARI) *Lunar*		Lunar Terrain Vehicles
22			Chandrayaan 3 (ISRO) *Lunar*		SLIM (JAXA) *Lunar*
23					Beresheet-2 (Israel) *Lunar*

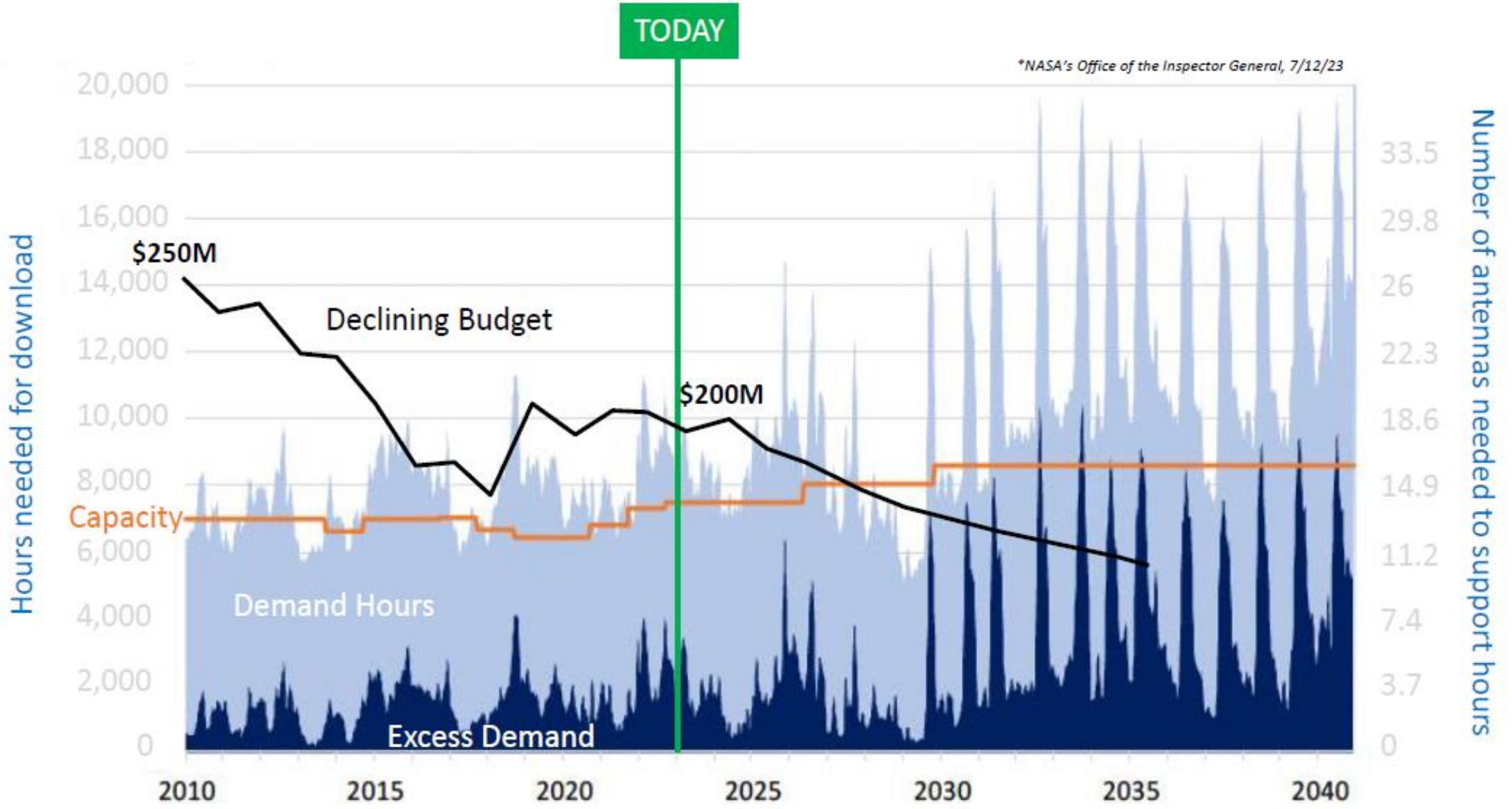
Artemis 1 and Cubesat Experience

Interplanetary Network Directorate

Artemis-I + Deep Space CubeSat Support: DSN Impacts



The DSN Budget is Declining while **Mission Load is Increasing**



NASA and the Community are Taking Notice

July 12, 2023

NASA
Office of Inspector General

Audit of NASA's Deep Space Network

"NASA's DSN is currently oversubscribed and will continue to be overburdened by the demands created by an increasing number of deep space missions, including crewed and robotic missions."

"NASA's DSN is vital to providing the communication links for the Agency's most complex and expensive space exploration missions such as the JWST and the Agency's Artemis lunar campaign."

April 24, 2023

Private Cloud Appliance (PCA) Failure Review Report

33-hour outage of GDSCC during Orion flyby of the moon due to PCA failure.

"Oracle PCA and operating systems out of date.... No redundancy"

"SCaN funding profile is a stressor on prioritization of Operations and Maintenance"

August 9, 2022

Joint SMD and SOMD Study evaluating DSN Support to JWST

"the DSN's ongoing challenge to balance limited supply and growing mission demand, was a key contributor to the challenges faced by JWST"

"19 findings across five categories... 17 recommendations and the corresponding 40 actions are listed in the report"

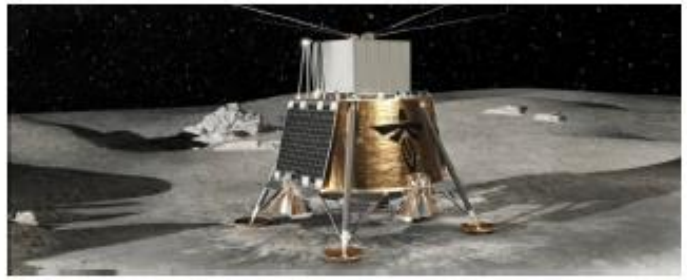
The **DSN is Vital** for NASA's Future

A DSN "Bad Day" can Lead to Loss of Critical Science, Missions or More

A bad day can be caused by lack of antenna supply, limited staffing, or fragility of the system

Increase in number and performance of robotic missions (~45 in 2023 to ~70 in 2033)

Bad Day: loss of communication or data and navigation of missions from cubesats to flagships



Increase in number of commercial missions

Bad Day: loss of communication or data of lunar missions

Addition of crewed missions require greater redundancy and reliability

Bad Day: human lives put at risk, reduction in the coverage of robotic missions

Road to a **Reliable Future**

RECOVER from decline

Add funding for all deferred sustainment tasks

$25M/year for 10 years

Restore workforce to ensure DSN viability. Succession planning and staff for increased workloads. Add ~60 people across DSN.

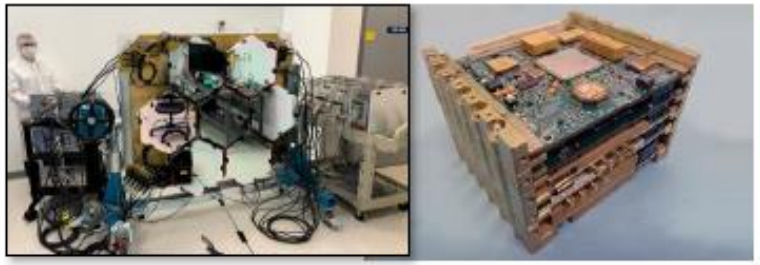
~$200K x 60 = $12M/year

Address effects of compounded inflation each year

(FY'23 ~$8M)

$45M/yr

RESTORE technology investment



Technology (flight and ground) is key to getting the most out of our antennas

Establish a balanced program that includes short, mid, and long term technology infusion

$15M/yr

RELIABLE FUTURE to meet demand

Restore (3) mothballed HEF antennas for S & X-Band

$10M/year, for 10 years

Add (3) more 34m DAEP antennas -

$20M/year for 10 years

$30M/yr

National Aeronautics and Space Administration

EXPLORE SCIENCE

Update on DSN Support for SMD: Briefing to NAC

August 29, 2023

Sandra Cauffman

Deputy Director, Astrophysics Division
SMD Liaison to SCaN

Continuing Challenges Associated with the DSN

Aging Infrastructure

- The DSN assets need to be maintained, sustained, and evolved to meet current and future needs. SMD perceives that the current SCaN funding profile is *not* sufficient to implement the needs of sustaining maintenance, nor incorporate new technologies to support future science missions.
    - The DSN has accumulated a significant backlog of deferred maintenance which can only be partly met.
    - Aperture-specific upgrades, as well as a prioritized network-wide plan has been established and being worked as funds allow.
    - There is a critical need for Near-Space 26GHz and the Deep Space 34GHz (Ka) bands to be implemented on more apertures as more projects are designing to these frequencies.
- Unexpected equipment failures are of prime concern, seeing as such could result in an immediate health/safety/science-return impact on SMD missions.
    - Since November 2022, there have been three ~24-hour+ full-site outages, including one during the Artemis 1 mission. Heroic efforts were required by SMD and SCaN to ensure there was no significant loss of science.
        - Since that time, the subsystems (PCA drives) that failed have been replaced at all three DSN complexes.

Continuing Challenges Associated with DSN – con't

Oversubscription and Demand

This is an on-going concern because the need is growing and challenging to predict.

- Current missions in prime and extended operations, and missions in development, increasingly generate more data than in the past with data rates from deep space growing by more than a factor of 10 since the 1960s.
- Many SMD missions are beyond their originally planned operational lifetimes but are still producing compelling science requiring DSN support beyond their initial commitments. This puts a strain on the system.

The SMD Senior Review process determines which missions are extended. The results can make it challenging for the DSN to anticipate the impact on network loading.

- If the current mission set remains operational into the next decade through mission extensions, the total number of missions needing DSN support could double (see side 5).

SMD has implicitly assumed DSN availability as part of the Decadal Survey process. It is unclear that the current plans can meet the anticipated requests, such as high data downlink needs at the Lagrange points and in the cis-lunar domain.

- SMD has implemented non-DSN solutions for some high data rate missions (e.g., Roman).

Additionally, DSN is an integral part of the Artemis architecture. While the planned Lunar Exploration Ground Site (LEGS) network performance is designed to meet driving cis-lunar needs, by offloading Artemis and other lunar missions from the DSN, Orion itself will continue to require DSN support for all future missions.

- SMD will have significant events in the 2024-2026 timeframe (see slide 4) that will significantly increase contention on DSN assets.

SMD Near-Term Drivers: 2024- 2026

Upcoming driving events present *additional* needs to DSN commitments.

- Planetary missions are driven by launch windows and critical events that cannot be easily moved. This is complicated by the need to deconflict with Artemis needs.
- There is a SCaN-lead lunar loading process that supports analyses of architectures that quantifies the ability to meet Artemis needs and the potential for schedule overlap with anticipated SMD mission demand.
- The same sort of process is being implemented for the generality of all DSN missions.

These analyses are being communicated through the agency: i.e. SMD, ESDMD, and SOMD to better understand and clarify the stresses on the DSN.

Mission	Event	Month, Year
Euclid	Launch	June, 2024
EscaPADE	Launch	October, 2024
MMX	Launch	October, 2024
Europa Clipper	Launch	October, 2024
VIPER*	Launch	November, 2024
IMAP (w/ 4 smallsats)	Launch	February, 2025
Europa Clipper	Mars Flyby	February, 2025
LUCY	1981 EQ5 Encounter	March, 2025
MOM-2	Mars Arrival	June, 2025
EscaPADE	Mars Arrival	June, 2025
MMX	Mars Arrival	June, 2025
Psyche	Approach	January, 2026
Psyche	Arrival	April, 2026
NEO Surveyor	Launch	June, 2026
Mars Ice Mapper	Launch	October, 2026
Mars Sample Return - L	Launch	November, 2026

*Intense DSN coverage between December 2024 to April 2025

Overall Predicted DSN Loading

DSN Missions Dashboard --- July 2023 (*Changes Monthly -- Contact S. Asmar*)					
	Completed In Recent Years	Current (count: 40) Deep Space	Current (count: 40) Near Space & Lunar	Future (count: 40) Deep Space	Future (count: 40) Near Space & Lunar
1	InSight	Juno	LRO	Psyche *(L 2023)*	Astrobotic Peregrine
2	DART	Lucy	SOHO	VERITAS	Astrobotic Griffin
3	GOES T	Perseverance	ACE	DAVINCI+	Lunar Node-1 CLPS
4	Geotail	Mars Odyssey	Wind	Dragonfly	Lunar Trail Blazer
5	Artemis 1	Mars Recon. Orbiter	MMS 1	Europa Clipper *(L 2024)*	IMAP
6	NEA Scout *secondary*	MAVEN	MMS 2	Janus A (Serenity) *in storage*	Carruthers (GLIDE) *rideshare*
7	CuSP *secondary*	Curiosity	MMS 3	Janus B (Mayhem) *in storage*	SWFO *rideshare*
8	LunaHMAP *secondary*	New Horizons	MMS 4	CU-E3	VIPER
9	Lunar Ice Cube *secondary*	OSIRIS-REx	Themis B	ESCAPADE Blue *Mars*	SunRISE
10	Team Miles *secondary*	Parker Solar Probe *Helio*	Themis C	ESCAPADE Gold *Mars*	GOES U (19)
11	ArgoMoon (ASI) *secondary*	Voyager 1 *Helio*	DSCOVR	Sample Return Lander	Roman Space Telescope
12	Omotenashi (JAXA) *secondar*	Voyager 2 *Helio*	Chandra	Earth Return Orbiter (ESA)	Artemis-2
13	Equuleus (JAXA) *secondary*	STEREO A *Helio*	JWST	Rosalind Franklin (ESA)	Artemis-3
14	INTEGRAL (ESA)	Akatsuki (JAXA)	TESS	EnVision (ESA)	Exploration Upper Stage
15	Hayabusa-2 Prime (JAXA)	BepiColombo (ESA)	CAPSTONE	HERA (ESA)	Gateway
16	LICIA Cube (ASI) *DART*	Hope, EMM (UAE)	TDRS 6-13 *emergency*	DESTINY+ (JAXA)	Human Landing Sys 1
17	Chandrayaan 2 Orb. (ISRO)	Trace Gas Orbiter (ESA)	Biosentinel *secondary*	Hayabusa-2 Extend. (JAXA)	Human Landing Sys 2
18	Chandrayaan 2 Land. (ISRO)	Gaia (ESA)	Lunar Flash Light *secondary*	MMX (JAXA) *(L 2024)*	Human Landing Sys 3
19	SpaceIL Beresheet (Israel)	Mars Express (ESA)	XMM (ESA)		Blue Origin Mark-1 SN-1
20			KPLO (KARI)		Blue Origin Mark-1 SN-2
21			Chandrayaan 3 (ISRO)		SLIM (JAXA)
22					Beresheet-2 (Israel)
23					
	Situational Awareness	Ground Based	Notes		
1	JUICE (ESA) *emergency*	Reference Frame Calib.	*By Oct. 2023: Chandrayaan 3, SLIM, Psyche, Hayabusa-2 Ext. move to Current*		
2	INTEGRAL (ESA) *emergency*	GBRA	*By Oct. 2023: Lunar Flash Light move to Completed*		
3	SoLo (ESA) *emergency*	HCRA	*Approx one quarter of missions are non-NASA*		
4	Milani/Juventas (ESA)	SGP	*Artemis-2 CubeSats unknown status*		
5	LUPEX (JAXA)	GSSR			
6	MOM-2 (ISRO)	DSSR			
7	Aditya (ISRO)	EGS			
8	Venus Orbiter (ISRO)	*GAVRT (non-DSN)*			

*Intense DSN coverag[illegible] between December 2024 to April 2025

Path forward for the DSN

Oversubscription and Demand Challenges:

Based on this projected loading, SCaN is attempting to increase capacity through three projects:

- DSN Aperture Enhancement Project (DAEP) – a new 34m antenna at each DSN site.
- Lunar Exploration Upgrade Sites (LEGS) – 18m class antennas to support cislunar activities.
- Lunar Communications Relay and Navigation Systems (LCRNS).
  - Although not a ground aperture, use of LCRNS is critical to preventing future lunar surface missions (like the Lunar Terrain Vehicle) from relying on direct-to-Earth (DTE) assets like the DSN.

Scheduling:

Multiple spacecraft in either the same part of the sky, say Mars or the Moon, or say on opposite sides of the sky, impose extreme stress on the network.

To support improved schedule adjudication and help mitigate times of severe contention on the DSN, SMD has provided an initial list of currently operating and future missions to the SCaN and the DSN. In addition, *SMD is working with SCaN to determine a process to help prioritize mission needs on the DSN, as an outcome of the JWST and Artemis Lessons Learned recommendations.*

SCaN and SMD are actively cooperating on a DSN Futures Study (more below) to feed long-range planning processes and ensure that future capabilities match the needs.

DSN Futures Study Update

DSN Futures Study

SCaN chartered an 18-month duration (beginning Q1 FY23) DSN Futures Study which is looking at both near-term issues (network scheduling efficiency, network and element brittleness, and fragility), and projected capability needs though 2050. The DSN Futures Study is also responsible to understand what probable technology will be available and when it could plausibly be infused into the DSN by the time the first crewed Mars missions are planned.

- The technical work will be done by a JPL/DSN team.
- The study will incorporate SMD (Decadals) and ESDMD (Lunar and Mars architectures) as long-term planning inputs.
- Study Team members also consist of NASA stakeholders / users from ESDMD, SMD, and SOMD and are, on a quarterly basis, to provide a ‘reality check’ that future needs are being addressed. The latest check on-gong is to ensure that the mission model used by the DSN is an accurate reflection of the respective directorates, as well as providing the latest architectures from the Lunar and Mars groups (Mars is in-hand).
- The plan is to have the final report vetted by the Space Studies Board.

Ongoing SMD / SCaN Coordination

Coordination continues

The SCaN Board of Directors (BOD) is being rechartered to reflect the reorganization of the Agency, with three co-chairs (SOMD, SMD and ESDMD) and will have the ability to make decisions that can be channeled up to the SOMD and Agency PMCs.

- The SUPRWG (SCaN Users Plans and Requirements Working Group) is now chartered as a technical arm of the BOD study specific items of interest to the board and make recommendations for actions.

Both SCaN and SMD are establishing primary Points of Contact to ensure close engagement and cooperation. Both sides attend meetings to better understand the environment each is operating under (SMD FPRs and SMD staff meetings).

SCaN worked closely with the SMD DAAR to update the standard Announcement of Opportunity (AO) language as it refers to SCaN to better reflect the current state of both the DSN and TDRS networks. A member of the SCaN HQ staff will now be a part of the peer review process as a voting member of the Technical, Management and Cost (TMC) evaluation (aka Form C) to evaluate the proposed solutions for communications, navigation, and spectrum needs.

This is all positive progress, but much work remains to ensure that SMD's science needs can be met in the decades to come.

NASA Advisory Committee
Science Committee
Summer Meeting
Aug 2023

Will Resume Soon

National Aeronautics and Space Administration

NAC Science Committee Summer Meeting 2023

NAC Science Committee Summer Meeting 2023

Dr. Ellen Williams

Chair, NAC Science Committee

Hear updates, deliberate, and formulate any needed advice on:

Day 1

- **SMD Update** – Receive an update from SMD Deputy Associate Administrator, Sandra Connelly
- **Deep Space Network** – Follow-on panel discussion to address:
  - SCaN Organization, Context & Challenges
  - DSN status and future planning
  - An update on SMD needs presented at the Spring Meeting

Day 2

- **NASA SMD Initiatives to Lower the Boundaries to Science Research**
  - A panel discussion that will highlight a sample of initiatives from across SMD that enable and empower everyone to experience and participate in science
- **Heliophysics Big Year** – the Public Lecture will focus on the upcoming global celebration of solar science staring October 2023 and ending December 2024.
- **Any topics raised by the DAC Chairs that would benefit from SC attention**

Report the results of our meeting and any other insights to SMD Associate Administrator Nicky Fox in our Outbrief

National Aeronautics and Space Administration

NASA SMD Initiatives to Lower the Boundaries to Science Research: *Earth Science Division Activities*

Dr. Manil Maskey
Earth Science Division
Science Mission Directorate
NASA Headquarters

Reducing research barriers

1 **Trilateral EO Dashboard**

- Global collaboration
- Education and training
- Data sharing
- Open source software

2 **VEDA**

- Open source software
- Accessible platform
- Standards & interoperability
- Interdisciplinary science

3 **AI Foundation Model**

- Partnerships
- Collaboration
- Open large scale AI models
- Reduced cost to build downstream applications

4 **Earth Information Center**

- Public outreach
- Education
- Promoting scientific insights

Trilateral EO dashboard

Trilateral EO Dashboard: objectives and timeline

First Release 2020

eodashboard.org

Objective 1

- **Demonstrate joint capabilities of NASA-ESA-JAXA to observe COVID-19's environmental and economic impacts from space**

Objective 2

- **Convey indicators to the general public and decision makers; and maximize the value of curated information**

Objective 3

- **Engage the wider public via outreach & competitions, e.g. EO Dashboard Hackathon, SpaceApps**

KEY ACHIEVEMENTS

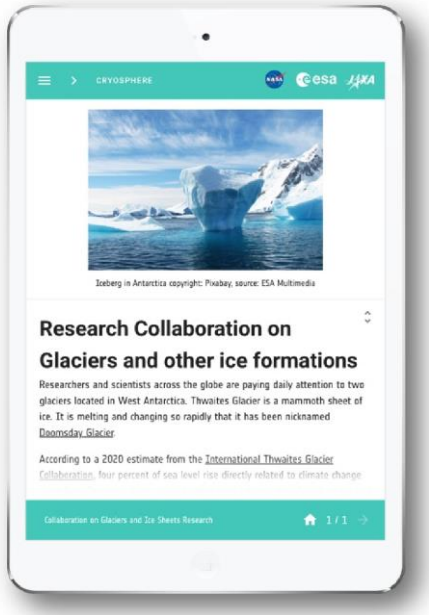
Rapid release
3 months
Eodashboard.org released in June 2020

EO Indicators
12 EO missions
Indicators based on data from 12 EO missions of ESA, NASA, JAXA

Global Presence
146 countries
Global awareness with accesses across the world

Communication
251 websites
Citations by 251 websites and joint participation in CEOS, AGU, SpaceApps, etc.

Trilateral EO Dashboard: ongoing collaboration



2021 - ongoing

Objective 1

- **Broaden scope for 7 thematic areas: atmosphere, oceans, biomass, cryosphere, agriculture, economy, covid-19, using open data and interoperability across agencies**

Objective 2

- **Communicate scientific findings via advanced visualization exploiting tri-agency EO data**

Objective 3

- **Promote Open Science best practices and engage with the community**

KEY ACHIEVEMENTS

Open Data

25 EO missions

Expanded EO indicators covering 7 new domains

Storytelling with Open Data

19 stories

Jointly developed stories to communicate tri-agency scientific findings

Training and Education and Open Science

5 Workshops

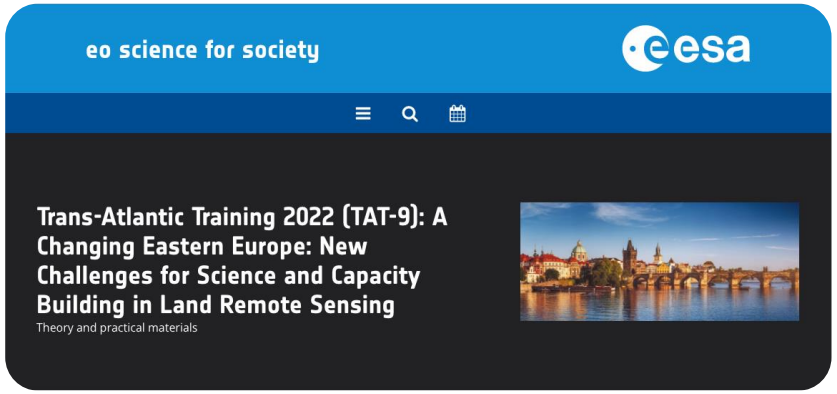
IGARSS tutorials and workshops, FOSS4G, LPS, EGU, GEO ODOK, etc.

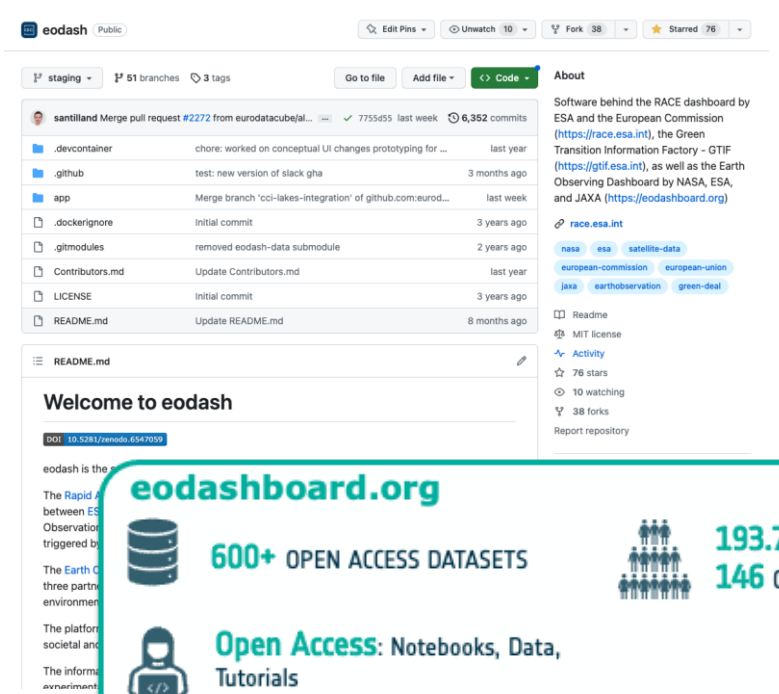
Promote Cooperation

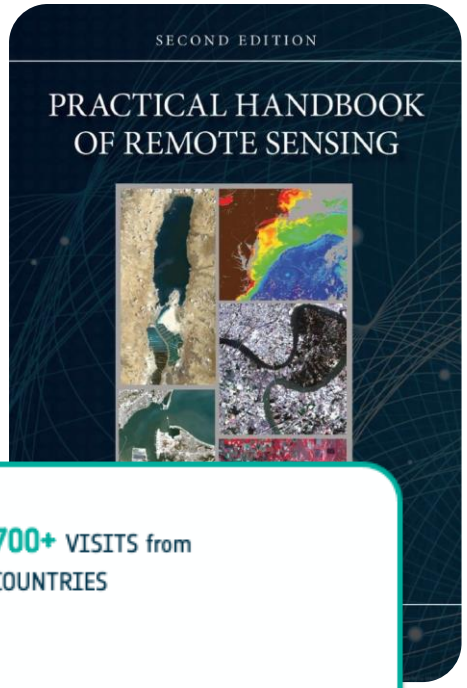
IAF Award

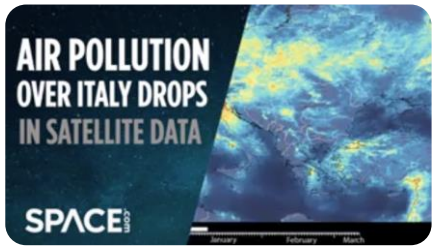
GLOC 2023 IAF Award

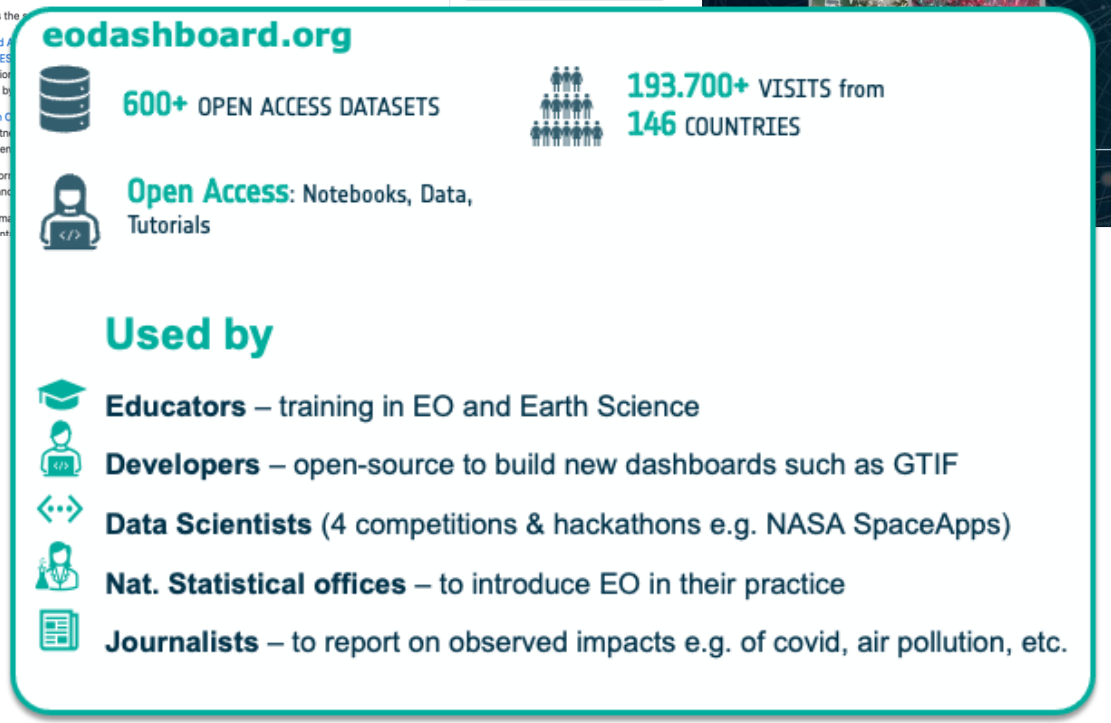
User community











IAF special award on Space for Climate Protection

23 May 2023, Global Space Conference on Climate Change, Oslo, Norway

The **ESA-JAXA-NASA Earth Observing Dashboard** was chosen as: "*the most valid example of the ways in which remote sensing data can support climate protection and allow decision-makers, citizens and the scientific community to easily access information that may be fundamental to protect our planet*."

NASA’s evolution from trilateral dashboard

Contribution to trilateral dashboard:

- Datasets and interoperable services for data transformation, access, and visualization
- Science expertise
- Infrastructure and services
- Coordination and host for data science challenges (SpaceApps)
- Communication and outreach

NASA has utilized components developed for the trilateral dashboard (and other investments) to assemble a platform called VEDA (Visualization, Exploration, and Data Analysis), which:

- Leverages data in the cloud
- Provides interoperable data services for other priorities
- Lowers the barriers to computing platform that is next to data
- Enables advanced visualization and exploration with enriched science communication

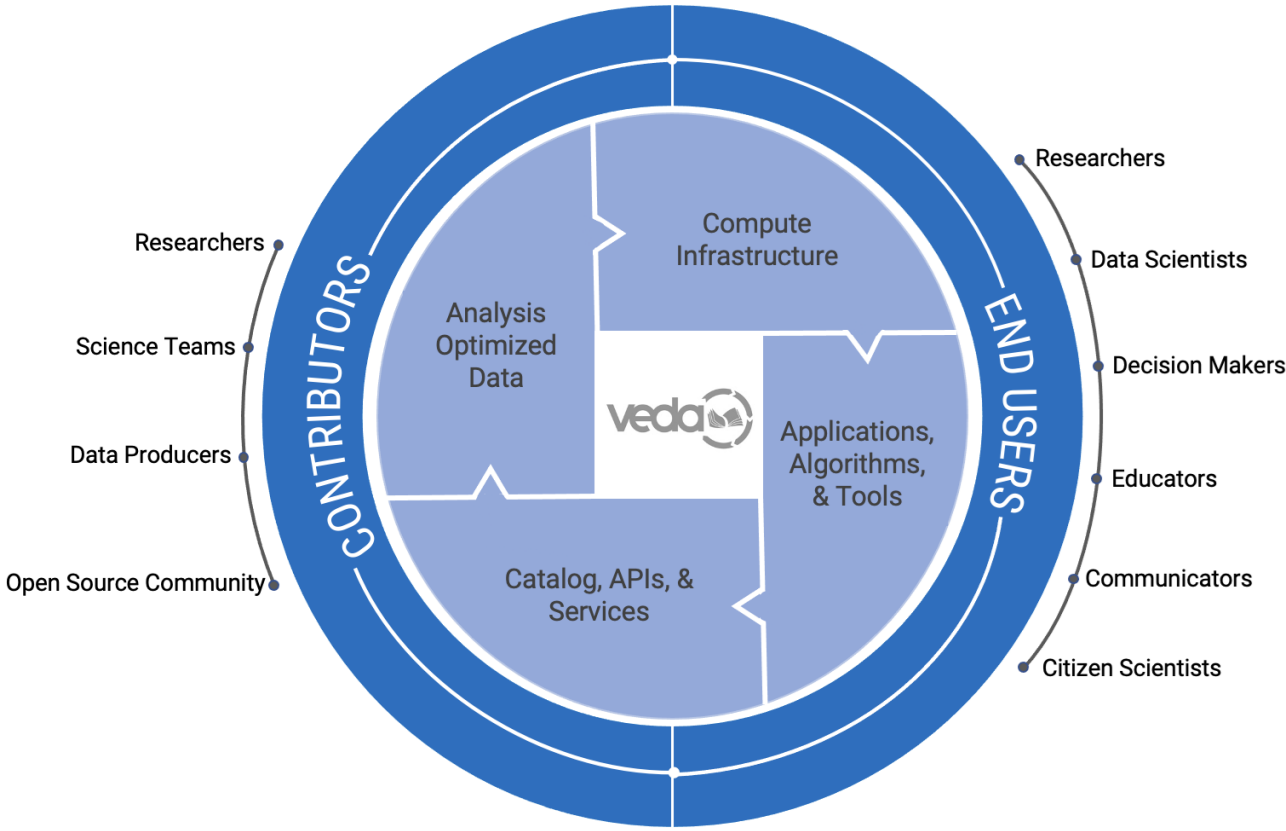
veda

Visualization Exploration & Data Analysis

Visualization, Exploration, and Data Analysis

Why?

- Interdisciplinary science depends on large amount of Earth science data and computational resources
- Working with these datasets is non-trivial
- Big data science requires advanced distributed computing knowledge

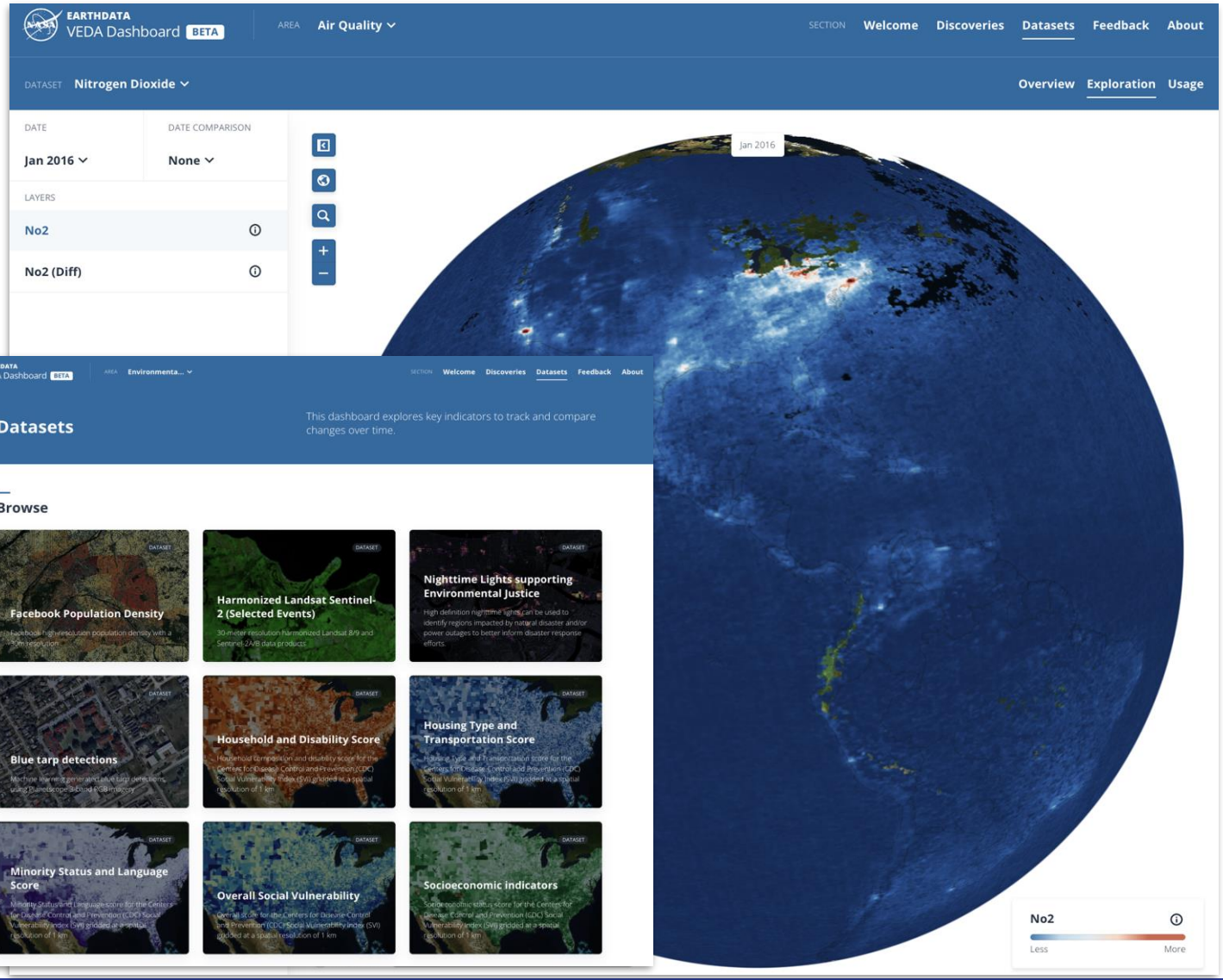


What?

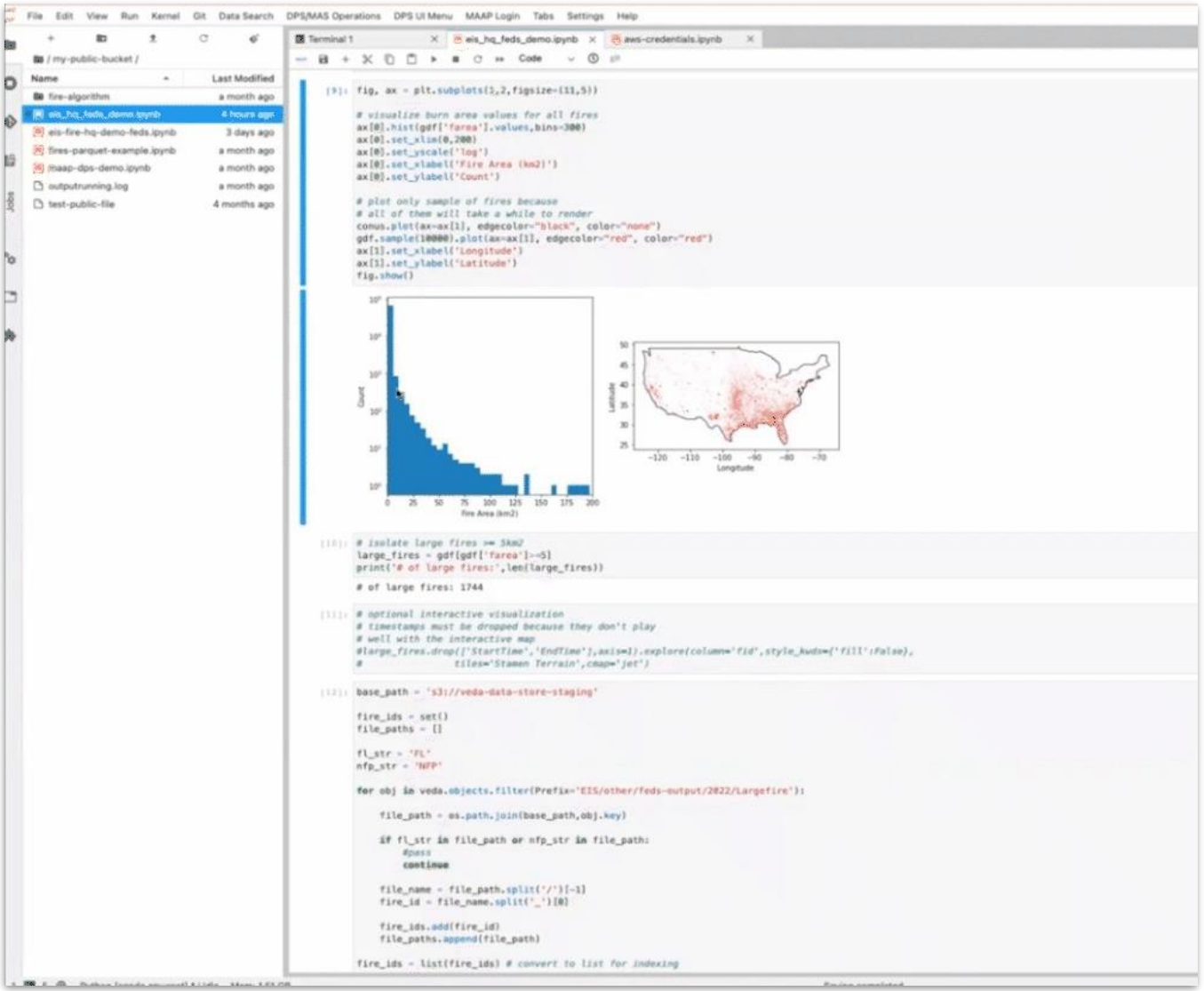
VEDA is an open platform that brings **key Earth science datasets next to open source tools** for data processing, analysis, visualization, and exploration in a managed and **more accessible computing environment**

Built using existing investments in open source software

Explore | Analyze | Publish | Communicate



- Finding relevant data products
- Exploring data to identify interesting features



- Developing advanced data products and analysis
- Carrying out calculations "in place" without the need to download data
- Dynamically allocating resources for computationally demanding processing

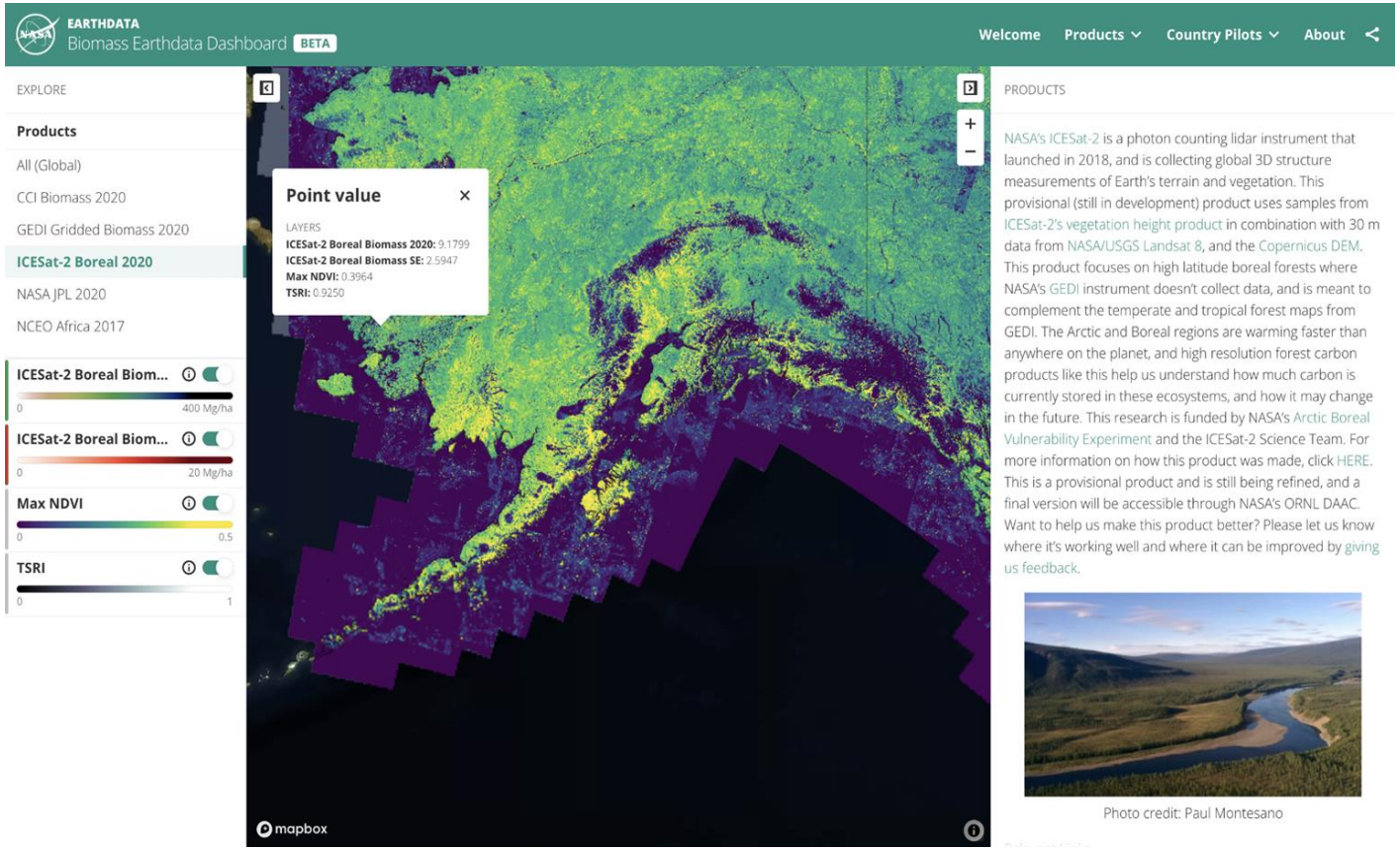
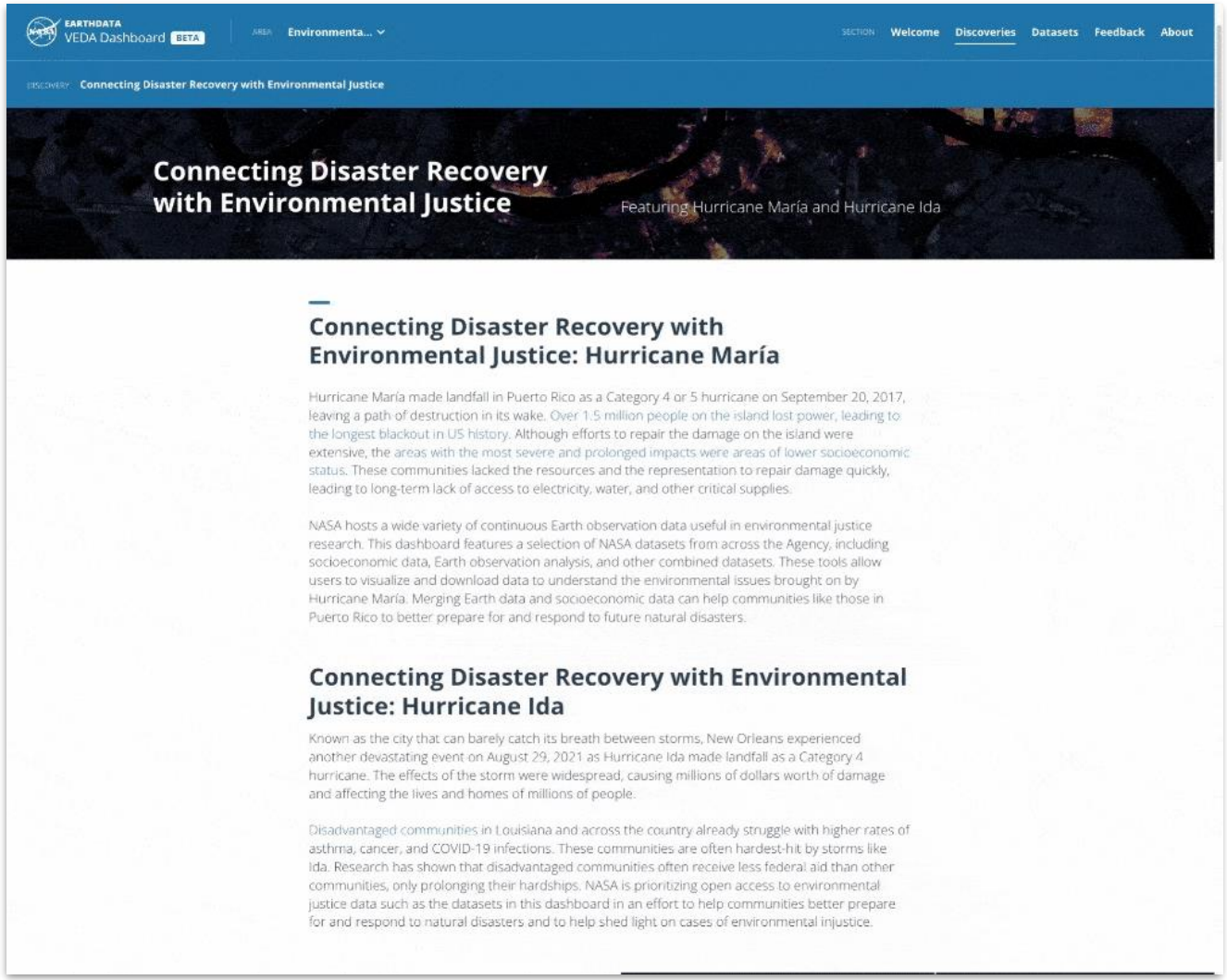


Photo credit: Paul Montesano

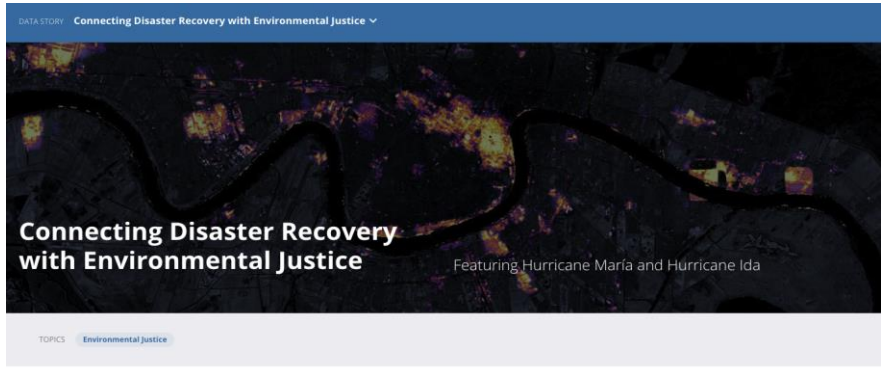
- Conveniently delivering data through existing interfaces
- Providing automatic access to interactive visualization capabilities
- Allowing users to analyze your products within the environment



- User friendly data-driven storytelling
- Enrich science and applications narratives with interactive exploration

Capabilities supported by VEDA

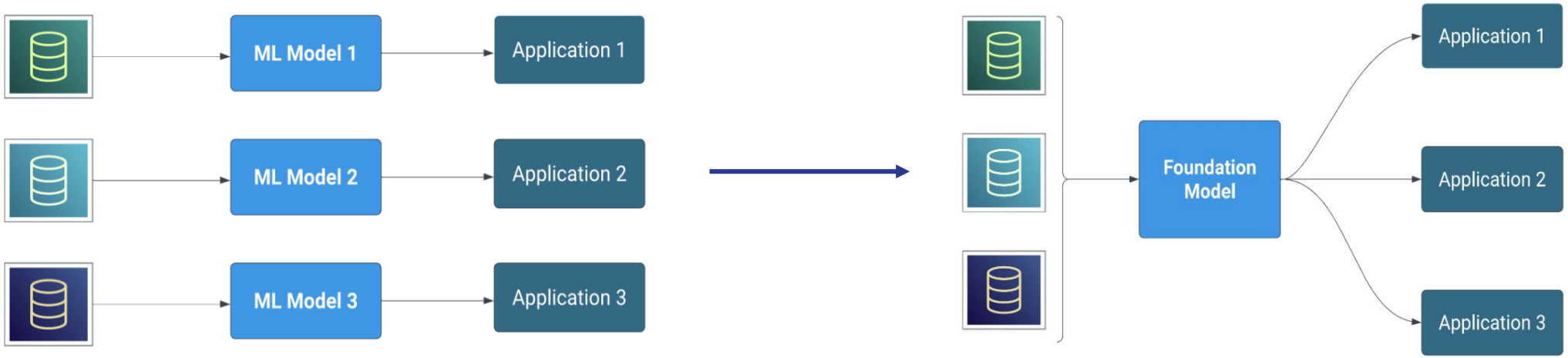
- Earth Information System
- Environmental Justice Initiative
- US Greenhouse Gas Center
- NASA/ESA/JAXA Trilateral Dashboard



Geospatial AI Foundation Model

AI Foundation Models

- Pre-trained on a comprehensive dataset and used for various downstream tasks
- Substantially reduce the downstream effort for building AI applications, including the need for large labeled training datasets
- Model captures emergent behavior within the data representation
- Creating a foundation model includes data curation, training, validation, and large-scale computation



AI challenges in Earth science

Advancing Application of Machine Learning Tools for NASA's Earth Observation Data

Jan. 21-23, 2020 | Washington, D.C.
Workshop Report

Maskey et al. "Advancing AI for Earth Science: A Data Systems Perspective," AGU Eos 2020

- **Training data** is the main component of supervised machine learning techniques and is increasingly becoming the **main bottleneck to advance applications of machine learning** techniques in Earth science.

- Geoscience models must **generalize across space and time**; however, for supervised learning one needs large training datasets to build generalizable models.

Release of the First Geospatial AI Foundation Model

Collaboration with IBM Research under a Space Act Agreement and NASA IMPACT project at MSFC

Pretrained on NASA Harmonized Landsat Sentinel-2 dataset

Examples of how it can be used:

- Burn scar mapping
- Flood detection
- Multi-temporal crop identification

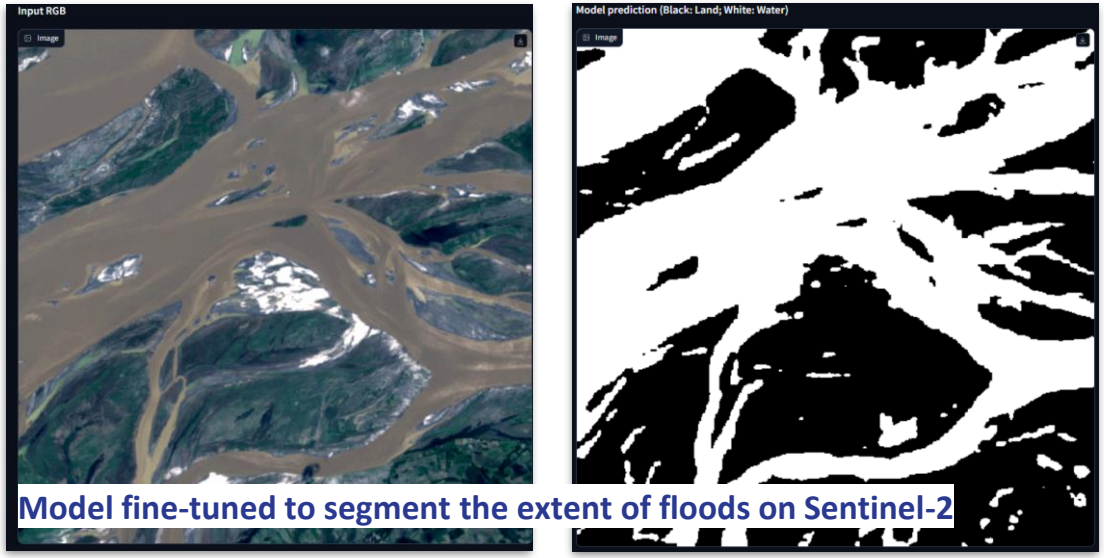
Openly available at Hugging Face including Models, Datasets, and Code.

*Released on **Aug 3rd, 2023***

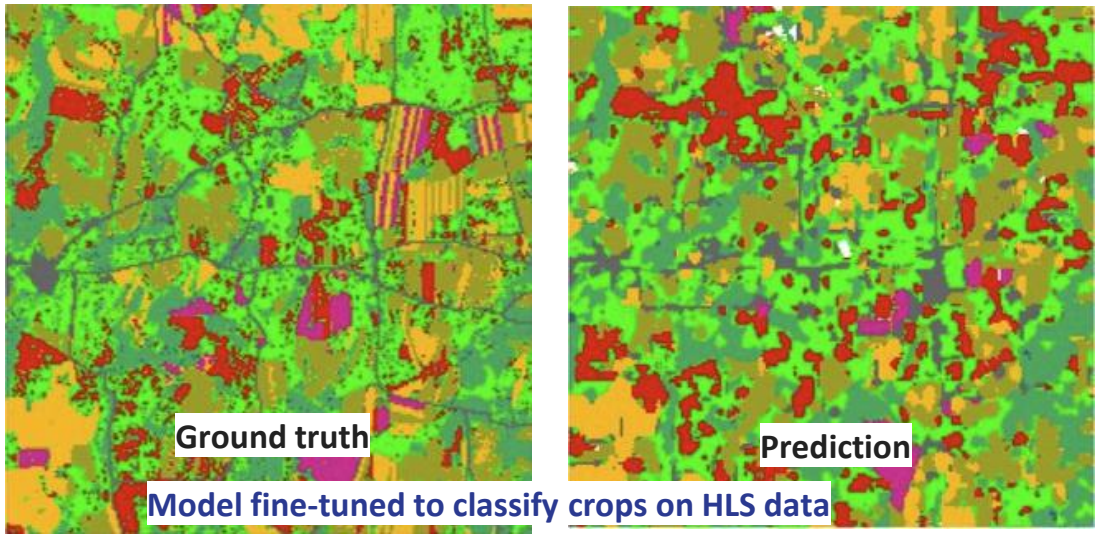
- *75 clones*
- *Several applications have already been built by community*
- *SpaceApps 2023 GeoAI challenge*

Collaboration with like minded partners IBM and Hugging Face

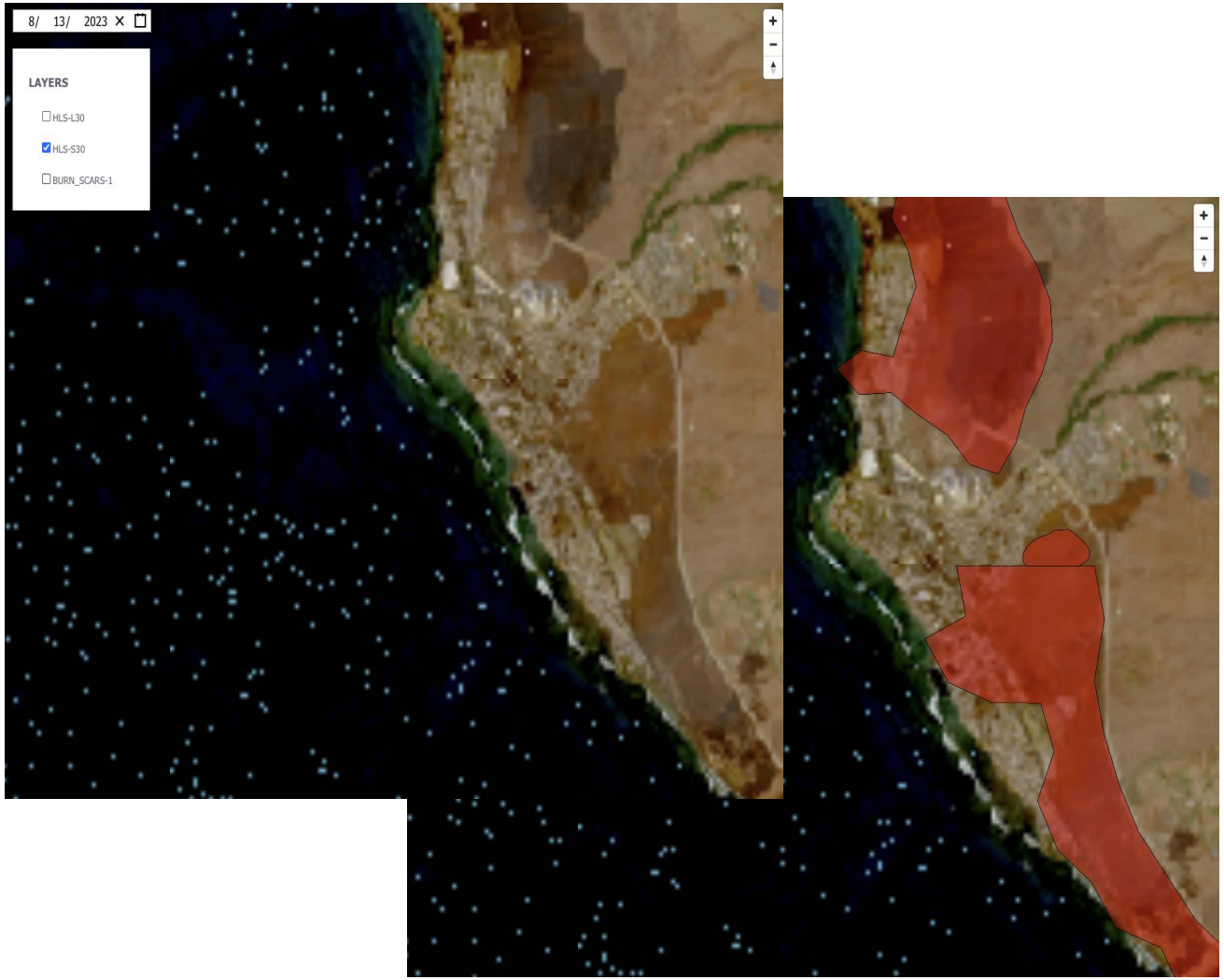
GeoFM: downstream applications



Model fine-tuned to segment the extent of floods on Sentinel-2



Model fine-tuned to classify crops on HLS data

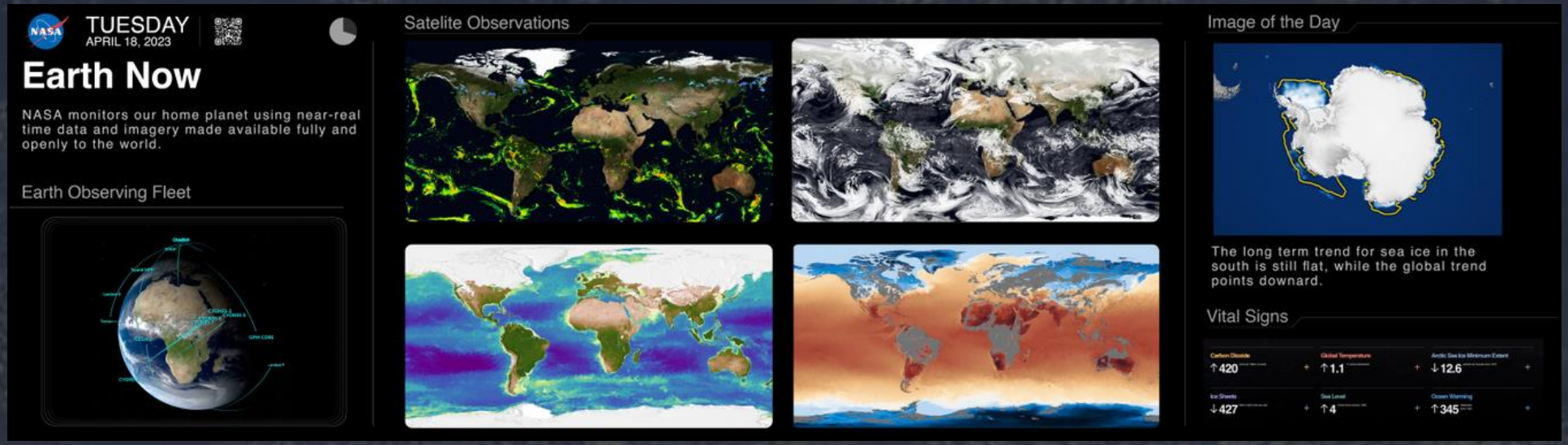


Burn scar mapping: Maui Fire 8.13.2023

Earth Information Center

Earth Information Center

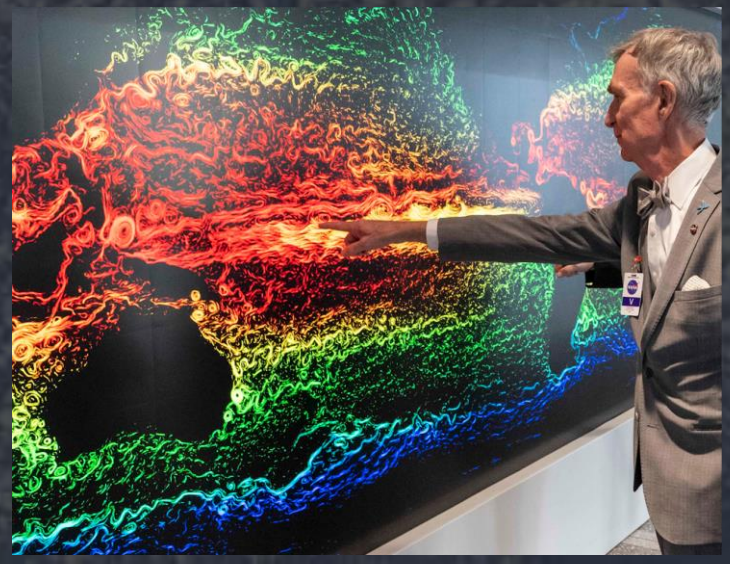
A physical and virtual space to engage and amplify impact – *to show people our Earth as we see it*. Visit the virtual site *at go.nasa.gov/eic*



A Hyperwall to highlight real time NASA data and stakeholder stories

Earth Pulse display showing Near Space Network NRT data collection

An immersive installation to allow visitors to go inside the data



Key takeaways

- Open data and platform ease scientific research barriers
- Standards and interoperability enable wider collaboration and maximize data use
- Core set of services based on open-source software offer agility needed for priority initiatives/projects
- Strategic partnerships accelerate research, especially through access to computation and technical expertise
- Community involvement enhances equitable and impactful scientific future

Thank you.

Manil Maskey

manil.maskey@nasa.gov

National Aeronautics and Space Administration

Lowering the Boundaries to Science Research

Curt Niebur
Lead Scientist for Flight Programs
Planetary Science Division, Science Mission Directorate
August 30, 2023

Lowering the Boundaries to Science Research

- Science Outreach vs. Science Engagement, as exemplified by
  - Europa Clipper Message in a Bottle
  - Here2Observe Program
  - Clipper Next Generation Initiative

Europa Clipper Message in a Bottle Campaign: *"We are creatures of constant awe"*

- The Europa Clipper Message in a Bottle campaign is a special collaboration, uniting art and science, by NASA, the U.S. Poet Laureate and the Library of Congress.
- The campaign invites the public to join the Europa Clipper mission and add their names to a poem written by **U.S. Poet Laureate Ada Limón, *"In Praise of Mystery: A Poem for Europa"***

- Participants can sign on in English at go.nasa.gov/MessageInABottle and in Spanish at go.nasa.gov/MensajeEnUnaBotella.
- The campaign will run from June 1, 2023, to December 31, 2023.

Underrepresentation in Planetary Science

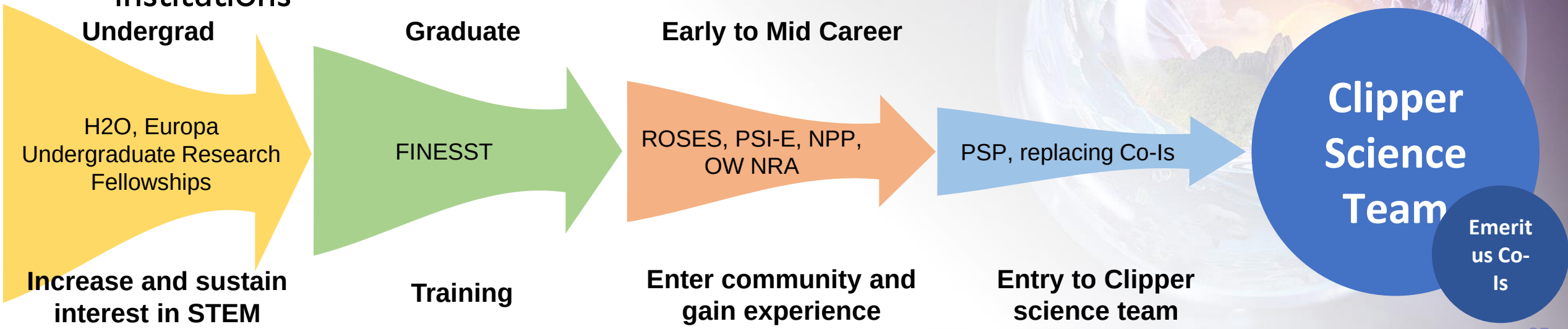
Race and Ethnicity	Percentage (2,367 Respondents)
Hispanic or Latinx	5%
American Indian or Alaska Native	1%
Black or African American	1%
Native Hawaiian or Other Pacific Islander	<1%
Another Race/Ethnicity	4%
Asian or Asian American*	13%
White*	83%

*Not underrepresented in Planetary Science

Data taken from 2020 Survey of the Planetary Science Workforce (Division for Planetary Sciences of the American Astronomical Society)

Growing the Next Generation of Leaders

- The goal is to create a Clipper science team that looks like the United States as a whole and is prepared to lead the Clipper extended mission
- Utilize existing and create new opportunities spanning the career lifecycle that capture and train the next generation from broader pools of talent
- Provide mentoring from Clipper science team for opportunities for undergrads, grads, postdocs
- Increase outreach, training, and opportunities to non-R1 planetary science educational institutions

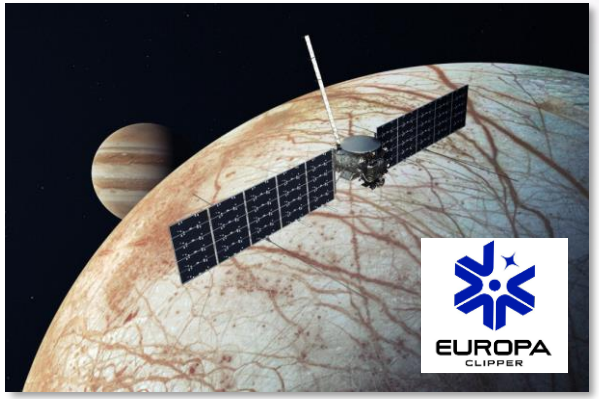


Opening doors to NASA PSD missions…

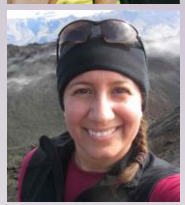
Our goal is to spark and maintain an interest for underrepresented students considering STEM careers

1. Encouraging a student-led program, aligned with student interests and needs.
2. Supporting meaningful mentorship activities.
3. Enabling cohort-building at the institution level.
4. Continuous program refinement through feedback and suggestions.

The H2O program was created and is managed by Dr. David Smith in PSD.

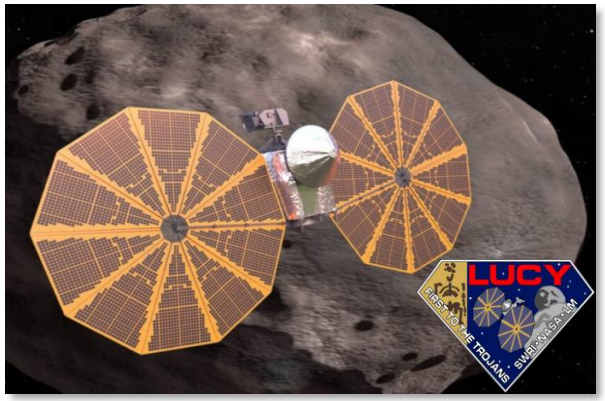


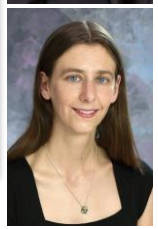

Ohio & Puerto Rico Space Grant Consortia
Robert Romero (Ohio Aerospace Institute)
Prof. Gerardo Morell (U. of Puerto Rico)
Dr. Rachel Klima (Europa Clipper Mission Liaison)

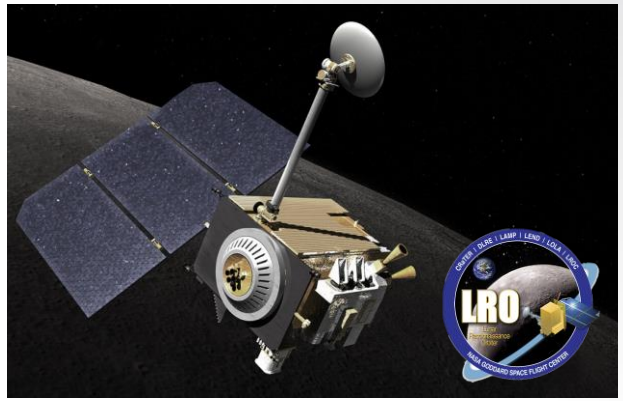
Kingsborough Community College
Prof. Steven Jaret (KBCC)
Dr. Alexandra Pontefract (Dragonfly Mission Liaison)


New Mexico State University
Prof. Nancy Chanover (NMSU)
Dr. Erika Kohler (DAVINCI Mission Liaison)



Univ. of Arkansas at Pine Bluff
Prof. Miah Adel (UAPB)
Dr. Katherine Kretke (Lucy Mission Liaison)




New Mexico Institute of Mining & Technology
Prof. Raúl Morales-Juberías (NMT)
John Van Eepoel (LRO Mission Liaison)


Virginia State University
Prof. Dawit Haile (VSU)
Dr. Ashwin Vasavada (Curiosity Mission Liaison)

National Aeronautics and Space Administration

2023 NASA SCIENCE

Asteroid Autumn: Science Access, Involvement, and Engagement

Thomas S. Statler
Program Scientist
Planetary Science Division and
Planetary Defense Coordination Office
2023 August 30

Asteroid Autumn Public Messaging: Why Asteroids are Important

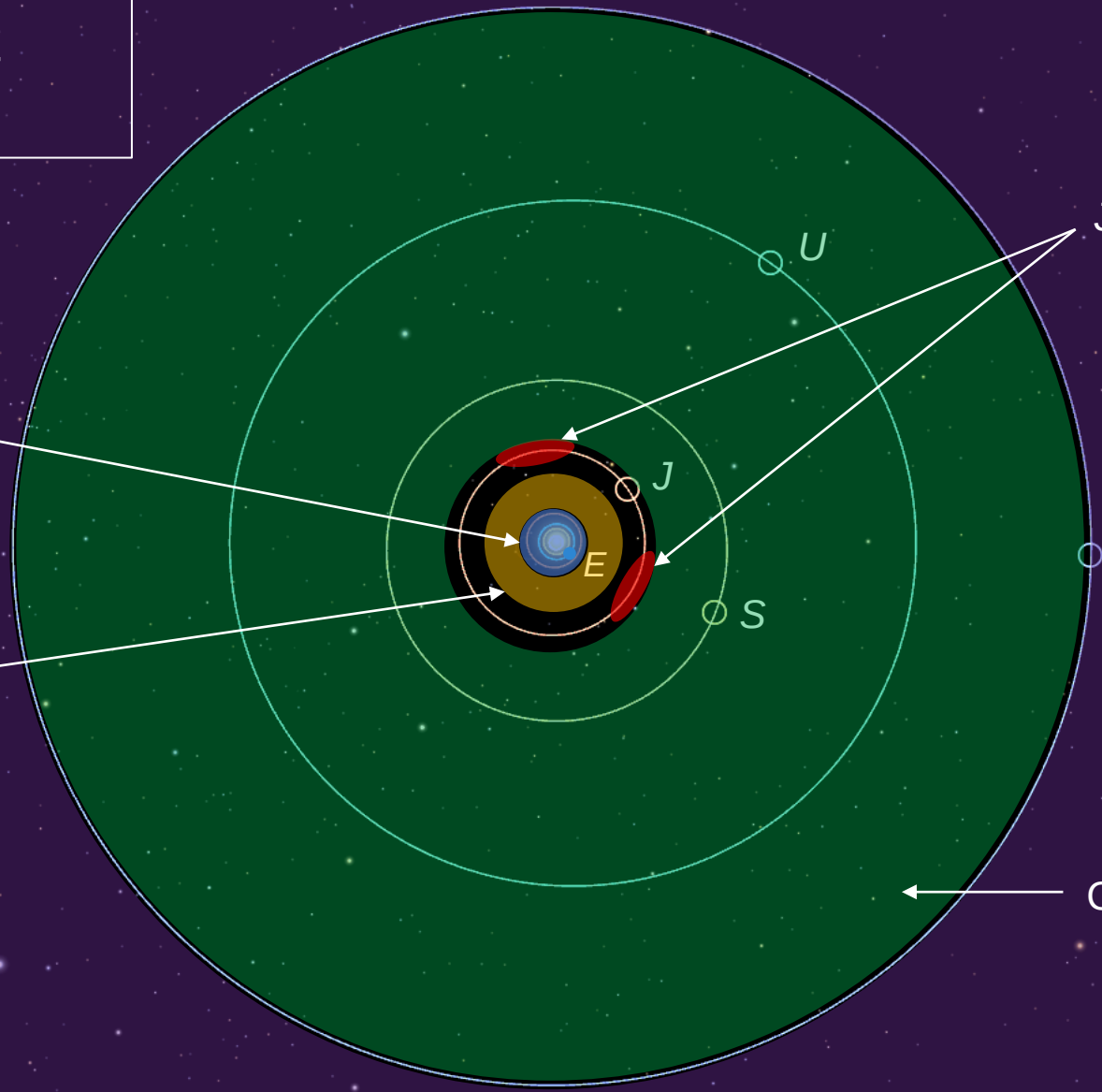
Asteroids are leftover raw materials from the formation of the planets.

Each asteroid tells a different part of the story of our Solar System.

Some asteroids pose a natural hazard to life on Earth.

Some asteroids may be useful to humans in the future.

Map of Our Solar System: Asteroid Populations & Mission Destinations



Jupiter Trojan Asteroids
(Lucy)

Near-Earth Asteroids
(DART, OSIRIS-REx)

Kuiper Belt Objects
(New Horizons)

Main Asteroid Belt
(Psyche, Lucy)

Centaurs

Asteroid Autumn Mission Milestones

September 24: OSIRIS-REx delivers Bennu samples to Earth

September 30: DART End-of-Mission

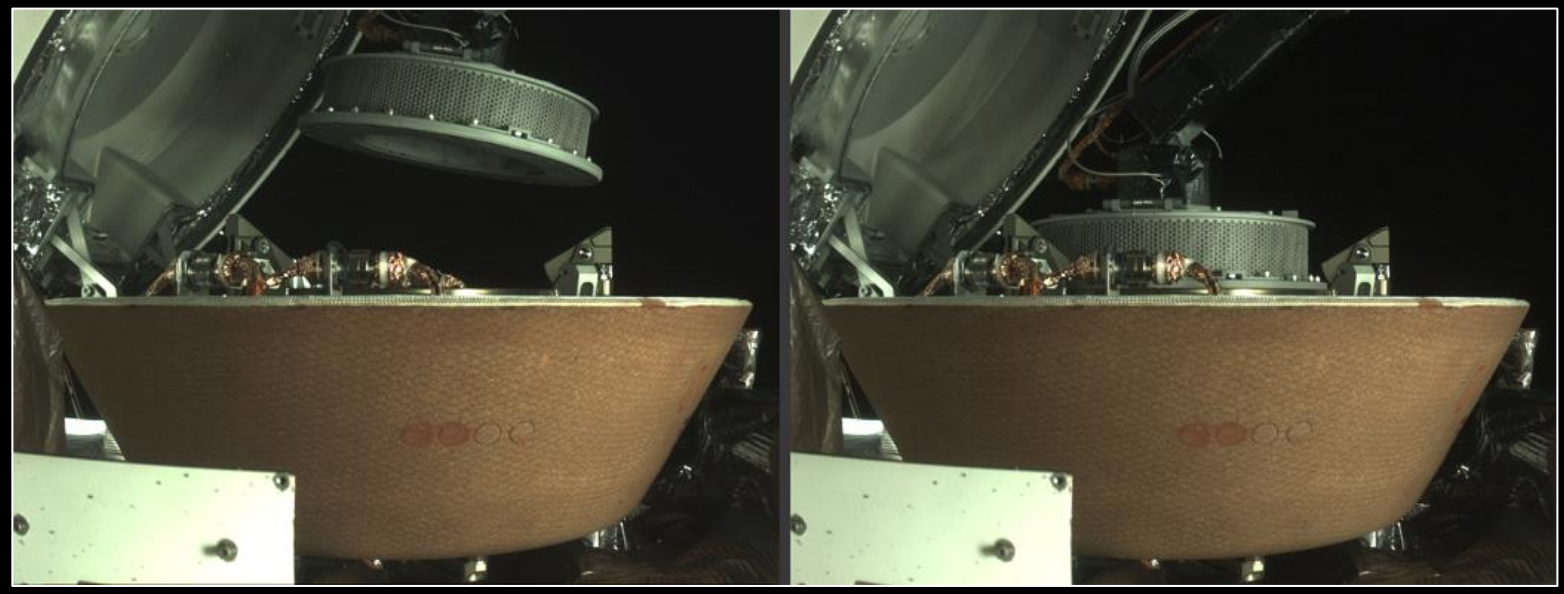
October 5: Psyche launch period opens

November 1: Lucy encounters main-belt asteroid Dinkinesh

OSIRIS-REx Sample Return

September 24

An estimated 250 g of regolith from asteroid Bennu will be delivered to Earth in the Sample Return Capsule, touching down at the Utah Test & Training Range.



OSIRIS-REx Student Engagement

To date OSIRIS-REx has supported:

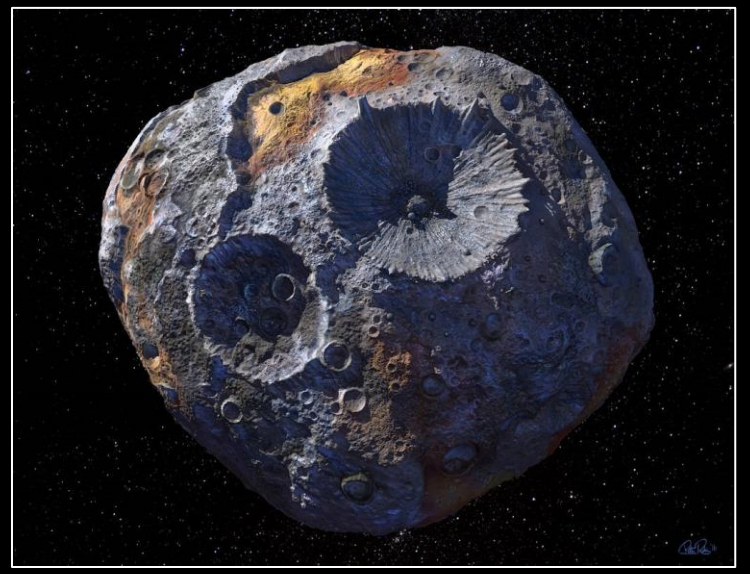
150 Undergraduate Student employees
22 Graduate Students

The University of Arizona (PI Institution) is a Hispanic Serving Institution in the border region, meaning undergraduate enrollment is at least 25% Hispanic.

When NASA partners with Minority Serving Institutions, a new early entry point into the pipeline is created for including students from underrepresented groups.

Psyche Launch Period Opens October 5

The Psyche mission will perform a comprehensive study of the highly metal-rich main-belt asteroid Psyche, which some lines of evidence suggest may be a remnant stripped core of a differentiated protoplanet.

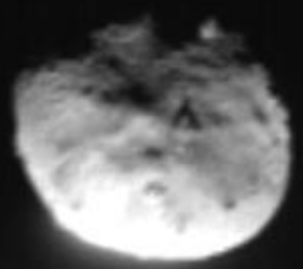


Psyche Student Collaboration & Public Engagement in 6th year

- Undergraduate senior capstone program in 6th year
  - Capstone has engaged more than 1,350 undergraduate students at 20 universities.
- Innovation Toolkit: Free online courses
  - Course 1 (complete): The Process and Lifetime of a Space Mission
  - Course 2 (complete): The Inclusive Mindset: Tools for Building Positive Team Culture
  - Course 3 (pending review): Countless Worlds in our Solar System: Asteroids, Comets, & Meteorites
  - Course 4 (final stages): Strategies for Troubleshooting Problems in Everyday Life and Work
- Psyche Science Outreach Interns and Docents

Psyche Hypothesized Surface Lander
(Michigan Tech mechanical engineering team)

DART End-of-Mission September 30



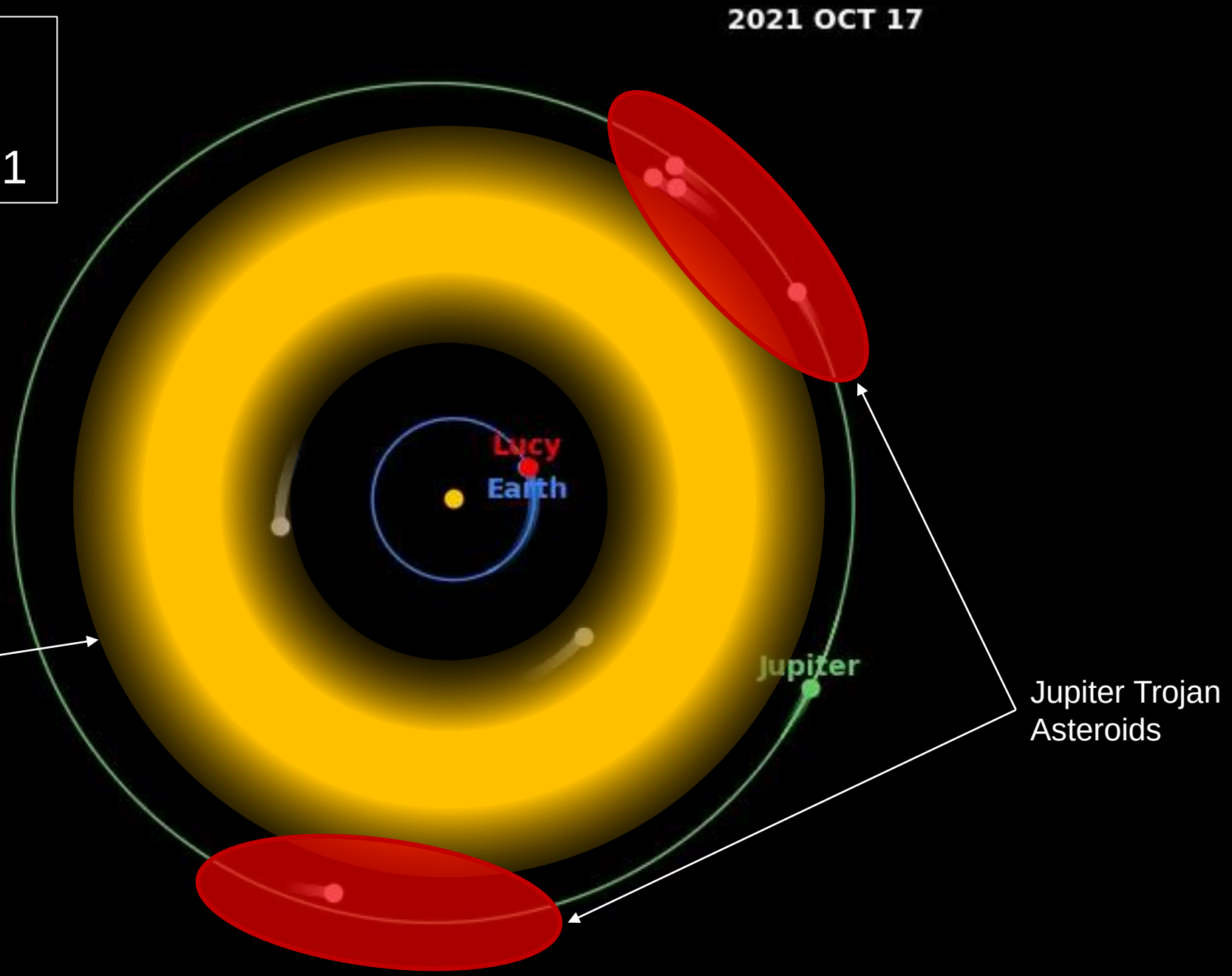
All DART and LICIACube data have been submitted to the Planetary Data System, and are currently in review.

30 days after release, community can propose projects using the data through ROSES.

“DART Boarders” Program

- Prior to H_2O program, w/o specific NASA support
- Early Career Researchers selected to observe Investigation Team Meetings
  - Jun 2021: 11
  - Jan 2022: 9
  - Feb 2023: 4
- > 20 U.S. institutions and 5 other nations represented.
- ”DART 101” sessions with Investigation Team leaders
- Paired with DART Co-Is as “trail guides” to field questions and provide networking opportunities
- Slack channel and dedicated social time provided
- A post-meeting, anonymous survey was circulated to assess results

Lucy Encounters Main-Belt Asteroid Dinkinesh for Engineering Test November 1



Lucy Student Pipeline Accelerator and Competency Enabler (L'SPACE)

- Two on-line, hands-on experiences for undergraduate STEM students:
  - Mission Concept Academy (MCA)
    - Skills training from NASA scientists and engineers; collaborate with other students to design a mission-related team project.
  - NASA Proposal Writing & Evaluation Experience Academy
    - Experience the process of writing, reviewing, and scoring proposals through the lens of a NASA reviewer. Compete for a $10,000 prize to continue developing the idea.
- Students may choose one Academy to apply for each semester.
- Current L'SPACE students and Alumni are encouraged to apply for a Lucy Summer Internship and/ or the Lucy Ambassador Program.

L'SPACE Program Metrics

POP: Fall 2018 – Summer 2023

Unique Students Enrolled in L'SPACE: 8,308

Completion Rate: Over 90%

Total # of Academies: 28
Represents over 700,000 hours of workforce development training

Total Reach: All 50 States, Puerto Rico and Guam

Total Colleges and Universities: 915
Total Community Colleges: 25%
Total Minority Serving Institutions: 29%

Total Students of Color: 35.87%
Black or African American: 8.23%
Hispanic or Latino: 24.98%
American Indian or Alaskan Native: 1.52%
Native Hawaiian or Pacific Islander: 1.14%

Gender:
Male: 58%
Female: 39%
Prefer Not to Say: 2%
Non-Binary: 1%

Lucy Internships

Total # of Lucy Interns: 175
Represents over 43,800 hours of workforce development training

Internship Sites:
Arizona State University: 131
Southwest Research Institute:15
NASA Goddard: 11
KinetX: 9
Lockheed Martin: 11

Total Interns of Color: 63%
Black or African American: 10%
Hispanic or Latino: 45%
American Indian or Alaskan Native: 6%
Native Hawaiian or Pacific Islander: 2%

Sample of Employers:
NASA Centers
NASA HQ
JPL
APL
LASP
Lockheed Martin
Space X
Boeing
Firefly Aerospace
Astra
Sierra Space

Engagement Through the Art-Science Interface

Psyche Inspired

- 6th year of artwork on the web/in museum exhibits – more than 325 works so far!
- Undergraduates from any discipline or major come together to share the excitement, innovation, and scientific and engineering content of the mission with the public through artistic and creative works.

Lucy Soundscape

- Composers/performers worldwide invited to share original music based on 3-note ”musical mission patch”
- Over 40 musicians have produced over 4 hours of Lucy-inspired compositions

NASA Advisory Committee
Science Committee
Summer Meeting
Aug 2023

Will Resume Soon

Biological and Physical Sciences

(formerly SLPSRA)

Moved to SMD in 2020

Dr. Jamie Foster, Chair BPAC (effective October 2023)
University of Florida, Space Life Sciences Lab

Dr. Michael Robinson, Designated Federal Officer BPAC
Fundamental Physics Program Scientist

Dr. Lisa Carnell, Division Director BPS
(appointed one month ago)

Biological and Physical Sciences

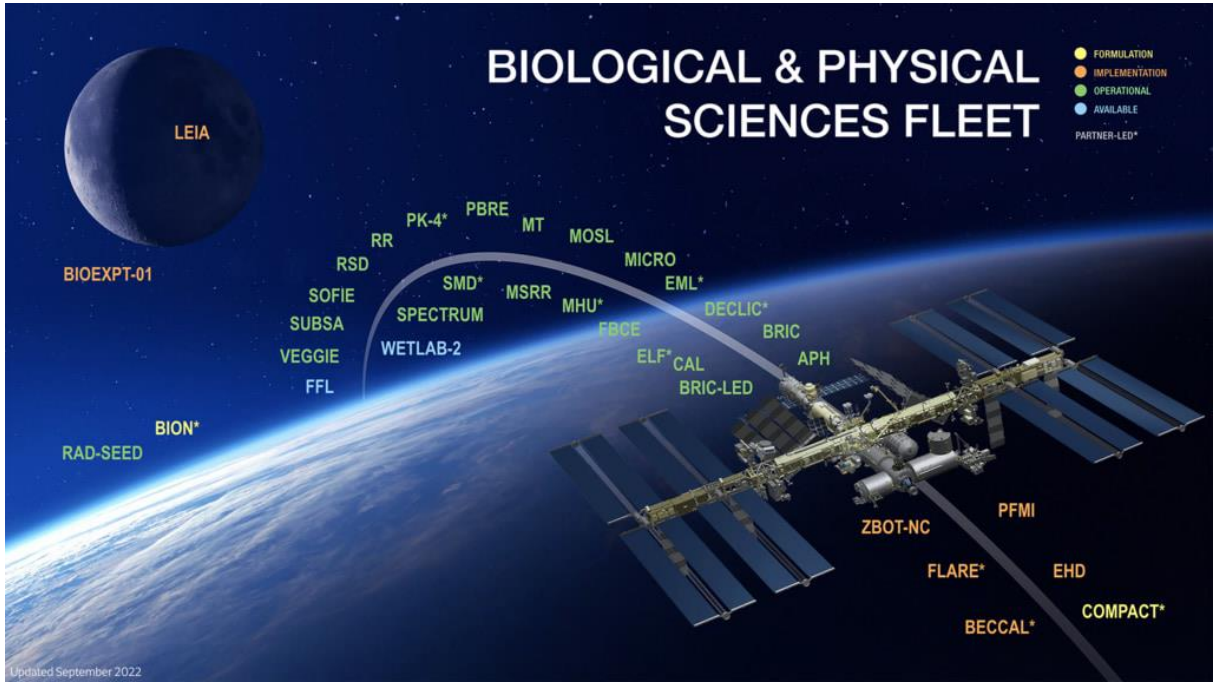
https://science.nasa.gov/biological-physical/data

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

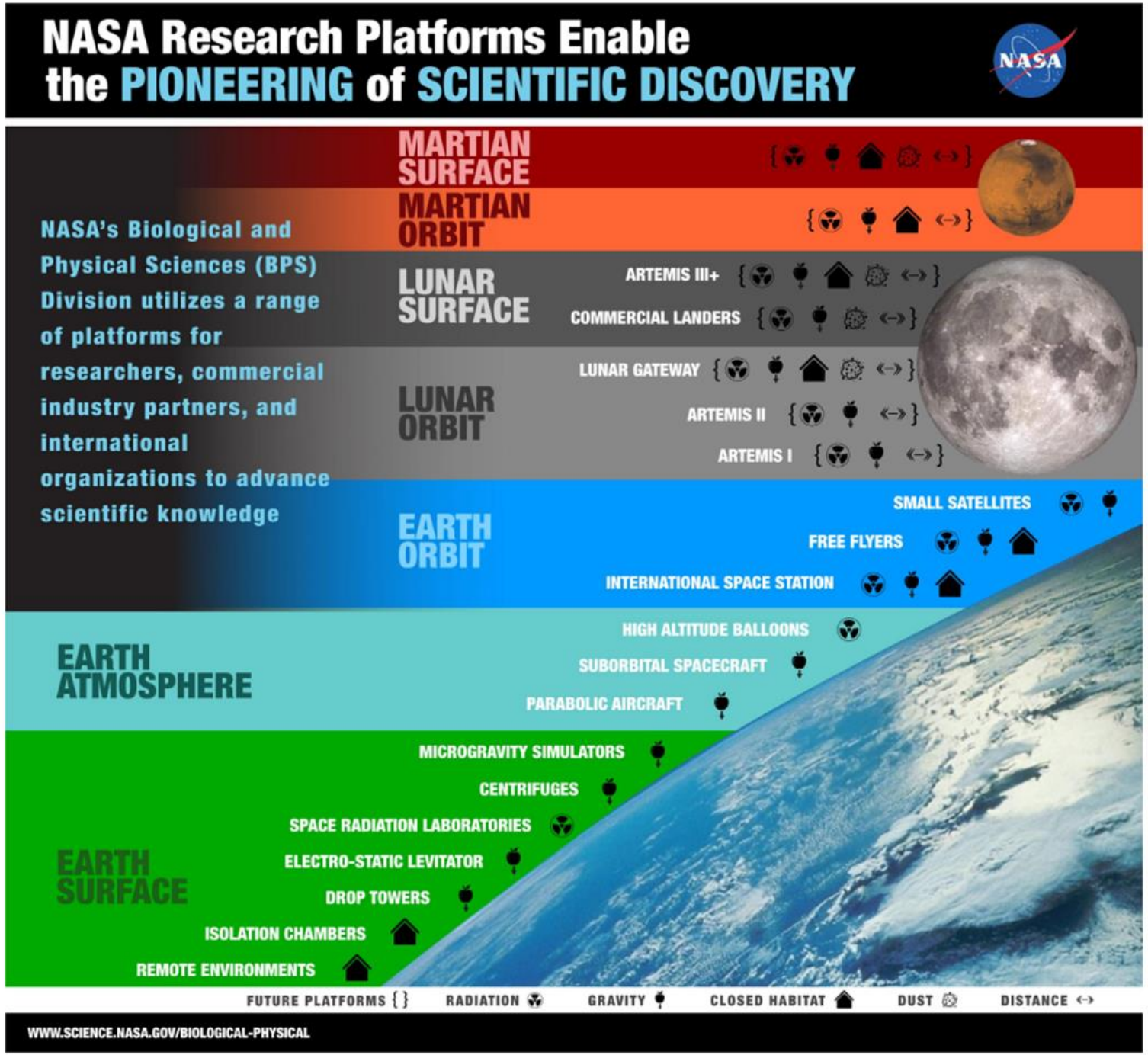
- pioneer scientific discovery
- enable human spaceflight exploration

BPS supports experiments on biological and physical systems in:

- ground-based laboratories
- on aircraft and balloons
- 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 .



***Future:**
Commercial Destinations in LEO

Biological Sciences

https://science.nasa.gov/biological-physical/programs/space-biology

The main objective of Space Biology research is to build a better understanding of how spaceflight affects living systems in spacecraft such as the International Space Station (ISS), or in ground-based experiments that mimic aspects of spaceflight, and to prepare for future human exploration missions far from Earth.

- Developmental, Reproductive and Evolutionary Biology
- Animal Biology
- Cell and Molecular Biology
- Microbiology
- Plant Biology

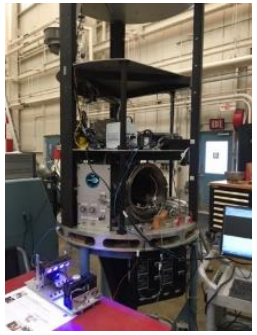
Ground-Based Research Facilities

HIGH ALTITUDE BALLOONS

PARABOLIC FLIGHT

MICROGRAVITY SIMULATION SUPPORT FACILITY (KSC / NL)

GROUND CENTRIFUGES



ZERO-GRAVITY DROP TOWER

On-Orbit Research Capabilities

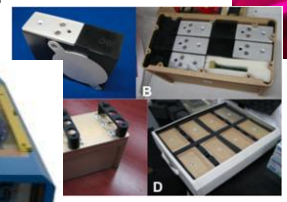
Glove Box

MELFI

VPS (Veggie)

MWA and KFT

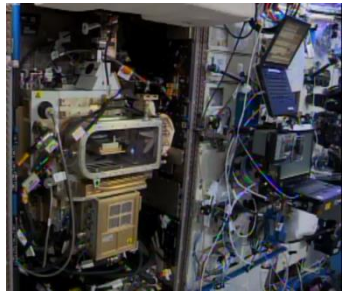
AEM-X



BRIC

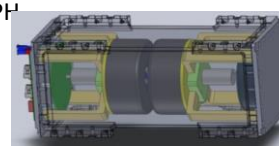
BIOTUBE

BIOCULTURE

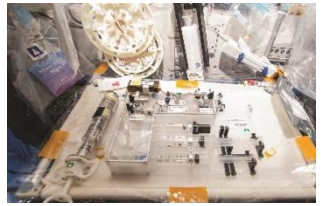


LMM

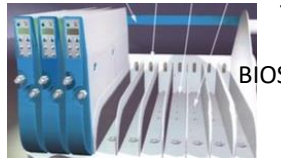
APH



SPORESAT

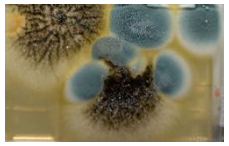


WETLAB-2

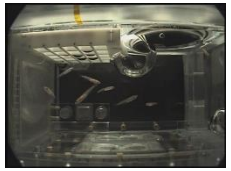


BIOS

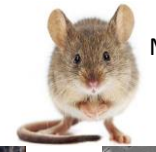
MICROBES



ZEBRA FISH



Science

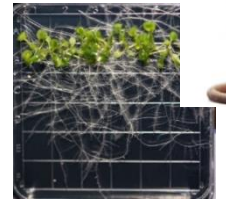


MICE

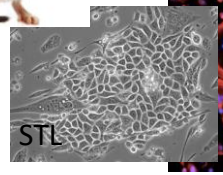
NEMATODES

SQUID

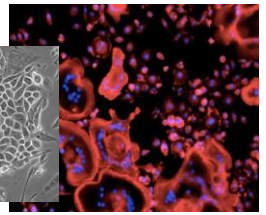
FRUIT FLIES



ARABIDOPSIS



STL



CELL BIOLOGY

Biological and Physical Sciences
Biological Sciences Highlights

Growing *Arabidopsis* in Lunar Soil

Food Crops in Microgravity

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?

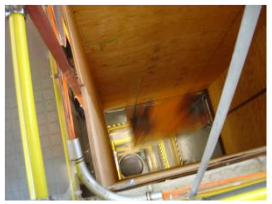
Physical Sciences

https://science.nasa.gov/biological-physical/programs/space-biology

Physical Science Research Program has made contributions in two distinct areas: first, fundamental research, which investigates physical phenomena in the absence of gravity and fundamental laws of the universe, and second, applied research, which contributes to the basic understanding underlying space exploration technologies.

- Biophysics
- Combustion Science
- Complex Fluids
- Fluid Physics
- Fundamental Physics
- Materials Science

2.2-Second Drop Tower



TSC

KC-135

Zero-Gravity Drop Tower

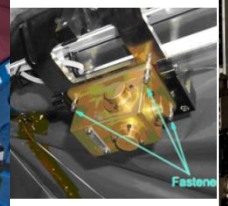
Ground-Based Research Facilities

MSG

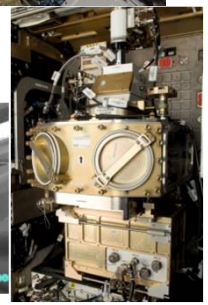
CIR

FIR

MSRR

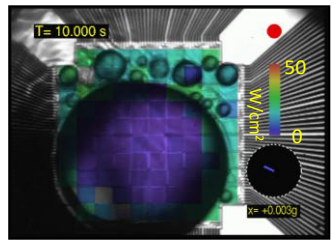


SAMS

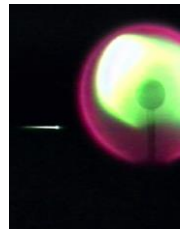


LMM

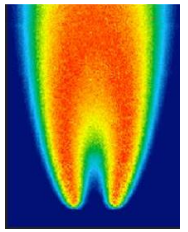
On-Orbit Research Capabilities



Pool Boiling

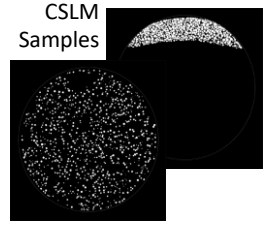


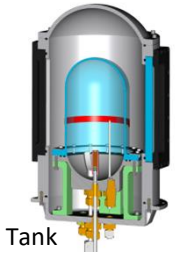
Flame Design



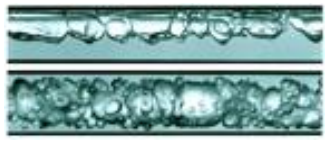
CLD Flame

CSLM Samples





ZBOT Tank

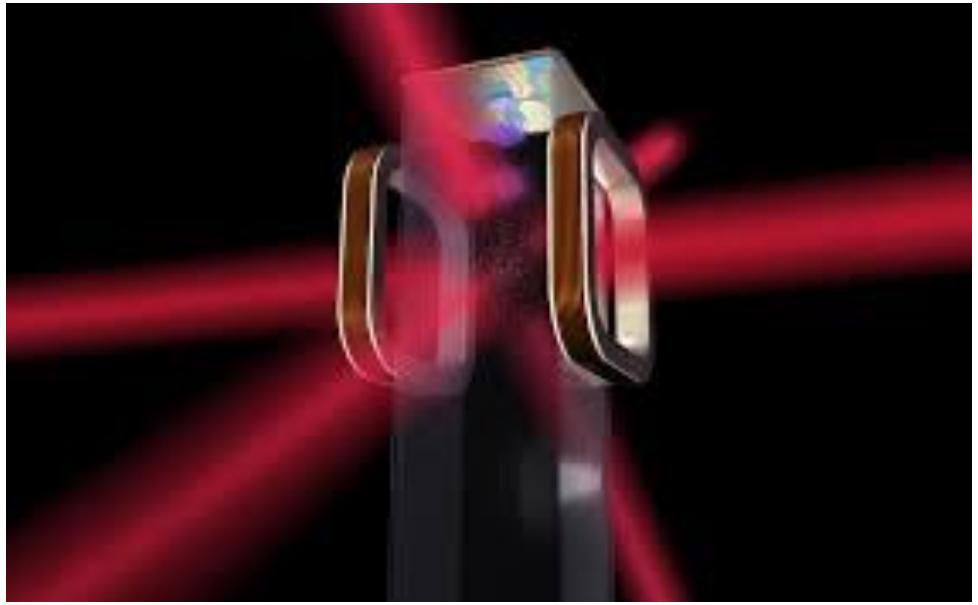


Two-Phase Flow

Science

Biological and Physical Sciences
Physical Sciences Highlight

Cold Atom Lab – Quantum Physics



Bose-Einstein Condensates
"fifth state of matter"
New geometries and topographies

Questions to address as ISS reaches end of life:

How will the CAL continue beyond ISS?
Could be transferred to a future CLD? (e.g., Axiom)
Could CAL be expanded by receiving investment from other federal agencies ?

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
- **Life Sciences Data Archive (LSDA)** – life sciences research data and information from decades of spaceflight and ground-analog research involving human, microbe, plant, and animal subjects.
- **ISC-ARC** – Non -human biorepository of the Institutional Scientific Collection at Ames Research Center

Physical Sciences

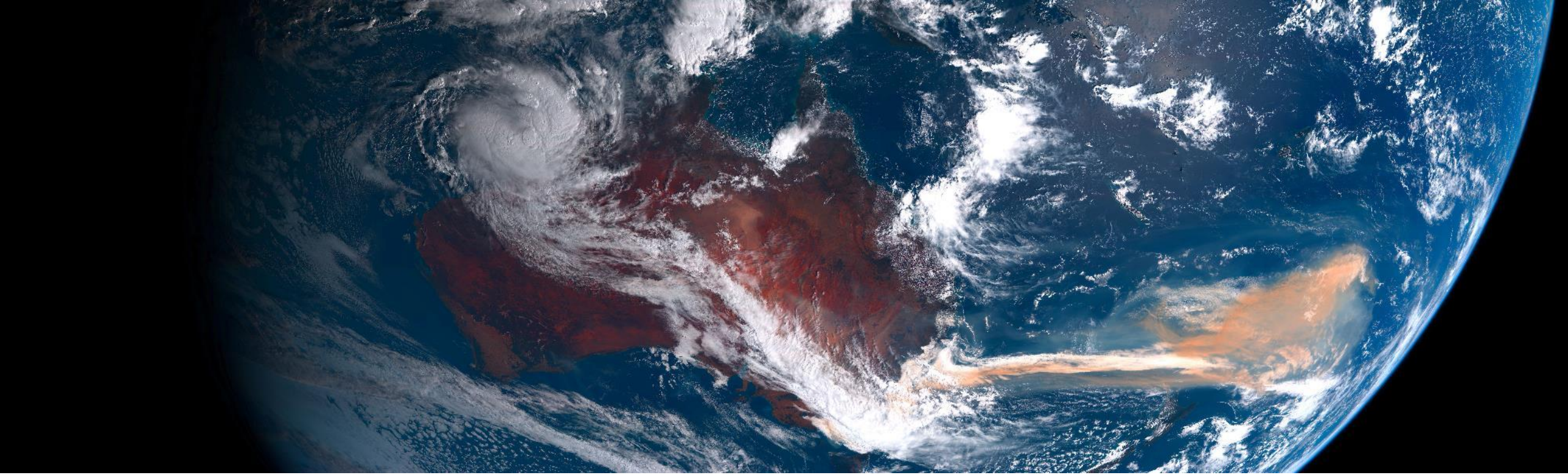
- **Physical Science Informatics (PSI)** – repository for physical science experiments performed on the ISS

NATIONAL ACADEMIES Sciences Engineering Medicine

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

OFFICIAL REPORT RELEASE DATE

on Tuesday, September 12, 2023 from 10:30am-12:00pm ET



Earth Science Advisory Committee (ESAC) Report

Sara Tucker, ESAC Chair

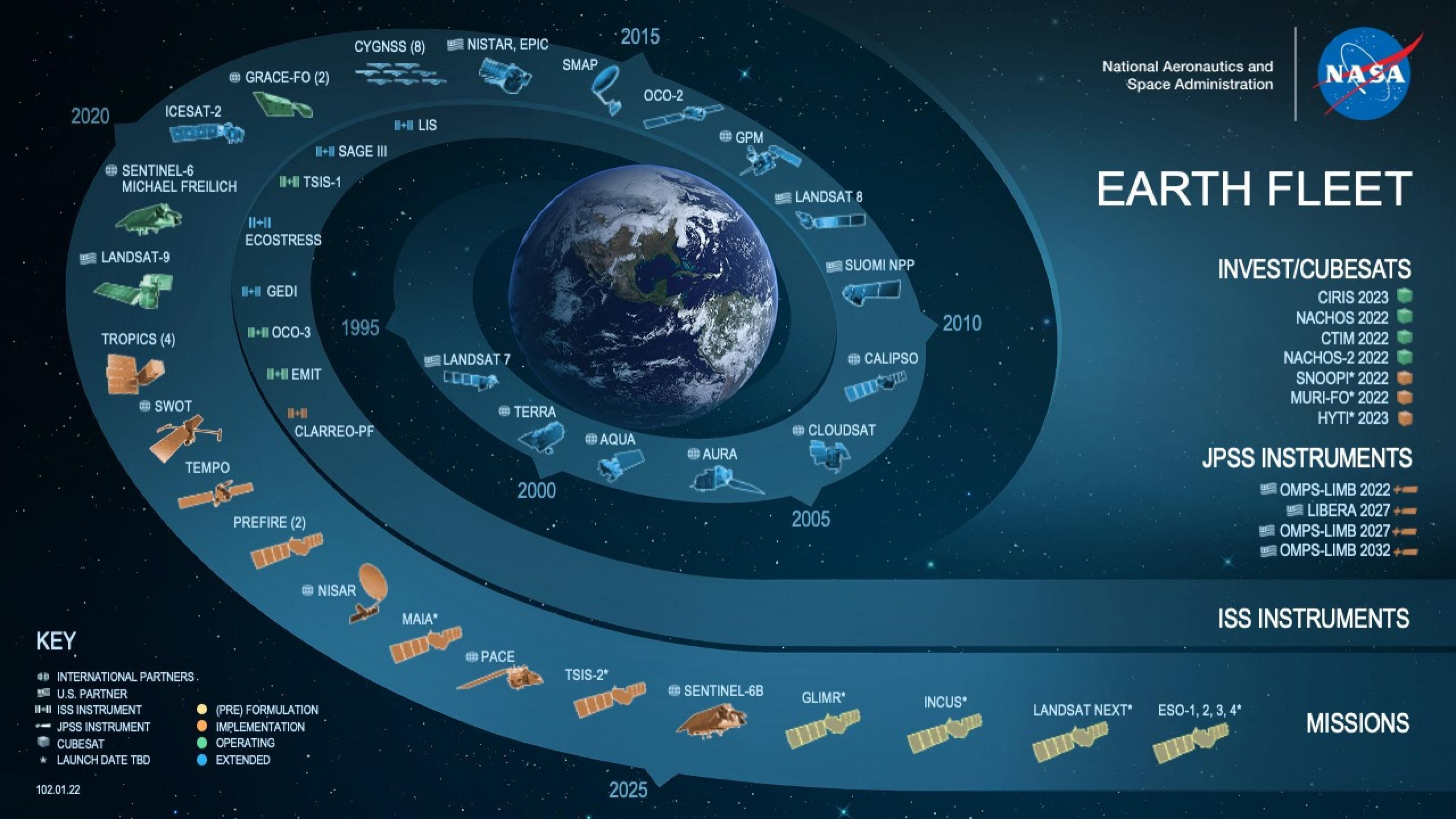
NASA Advisory Council Science Committee
Meeting at Jet Propulsion Laboratory
29-30 August 2023

NASA Earth Science Advisory Committee

- ESAC Executive Secretary - Lucia Tsaoussi
- ESAC Members
  - 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
  - Beth Plale - Indiana University
  - Robert Wright - University of Hawaii
  - Lisan Yu - Woods Hole Oceanographic Institution
  - Anastasia Romanou - Columbia University
  - Colleen Mouw - University of Rhode Island
  - Daven Henze - University of Colorado
  - Jasmeet Judge - University of Florida
  - Lucy Hutyra - Boston University
  - Nancy Glenn - Boise State University
  - Sara Tucker, Chair - Ball Aerospace

ESAC Meetings -

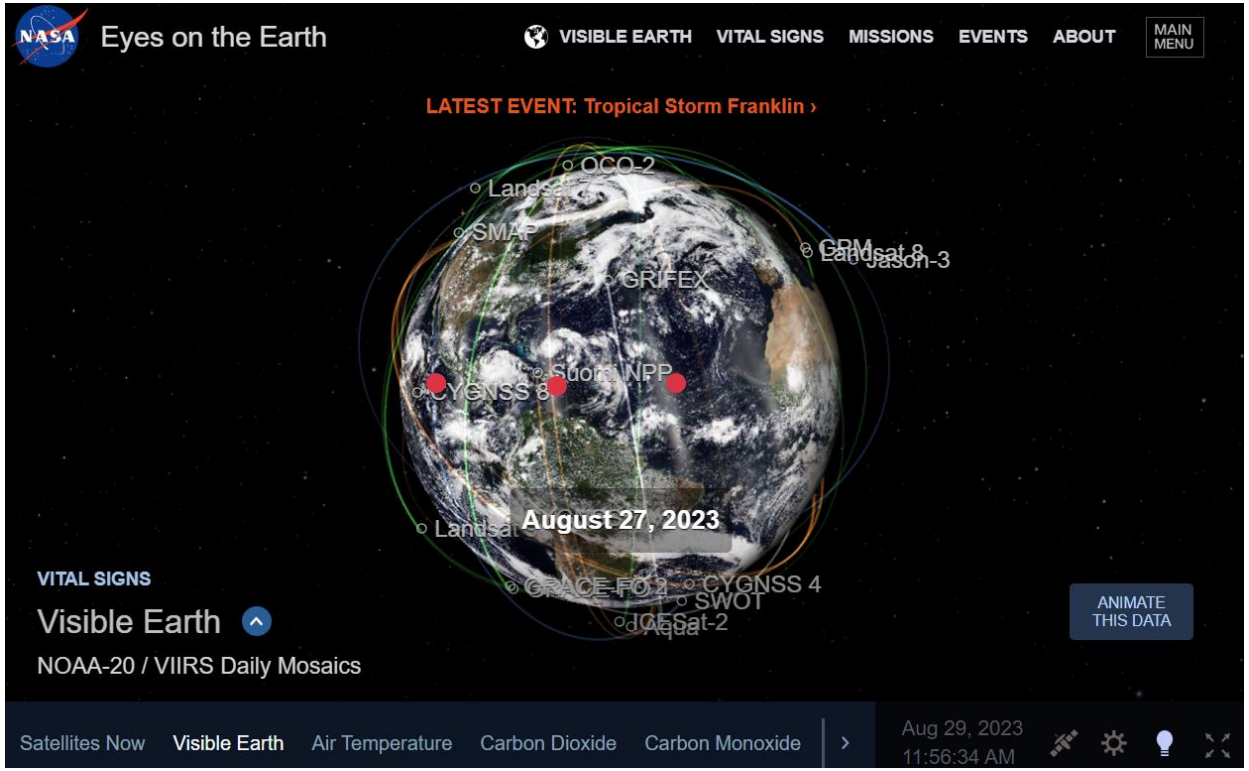
- Previous meeting: GPRAMA annual report review, October 2022 (virtual)
- Next meeting: GPRAMA annual report review, October 2023 (virtual)


National Aeronautics and Space Administration
NASA
EARTH FLEET
2015
CYGNSS (8)
NISTAR, EPIC
SMAP
OCO-2
GPM
LANDSAT 8
SUOMI NPP
2010
CALIPSO
CLOUDSAT
AURA
AQUA
TERRA
LANDSAT 7
2005
2000
1995
2020
GRACE-FO (2)
ICESAT-2
LIS
SAGE III
TSIS-1
SENTINEL-6 MICHAEL FREILICH
ECOSTRESS
LANDSAT-9
GEDI
OCO-3
TROPICS (4)
EMIT
SWOT
CLARREO-PF
TEMPO
PREFIRE (2)
NISAR
MAIA*
PACE
TSIS-2*
SENTINEL-6B
GLIMR*
INCUS*
LANDSAT NEXT*
ESO-1, 2, 3, 4*
2025
INVEST/CUBESATS
CIRIS 2023
NACHOS 2022
CTIM 2022
NACHOS-2 2022
SNOOPI* 2022
MURI-FO* 2022
HYTI* 2023
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
(PRE) FORMULATION
IMPLEMENTATION
OPERATING
EXTENDED
102.01.22

Earth Science Highlights

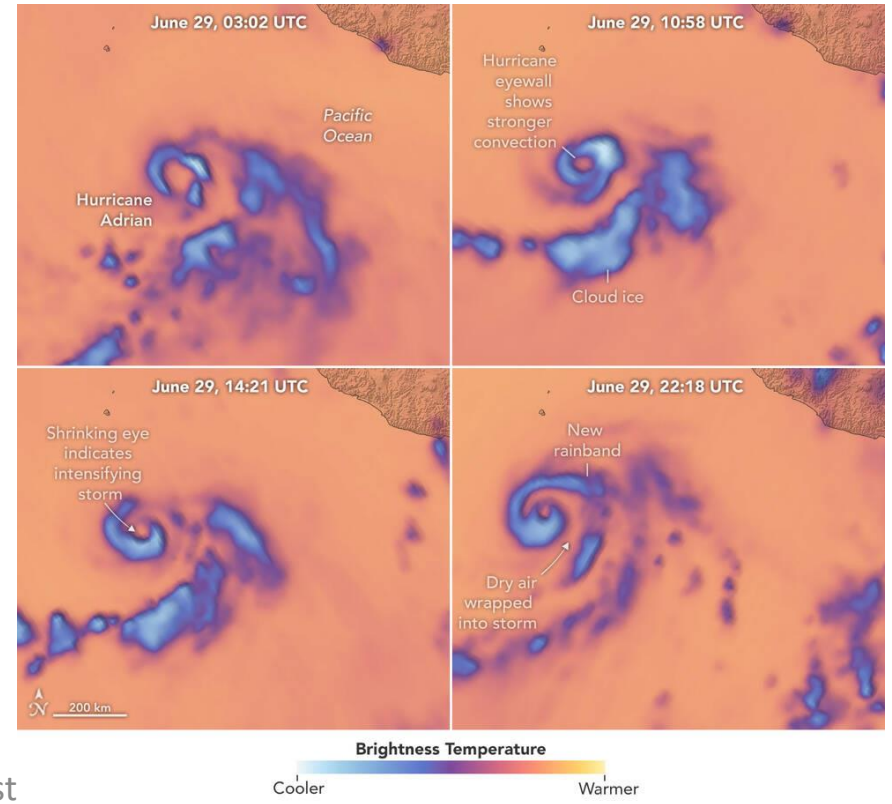
Earth Information Center @ NASA HQ

https://eyes.nasa.gov/apps/earth/#/



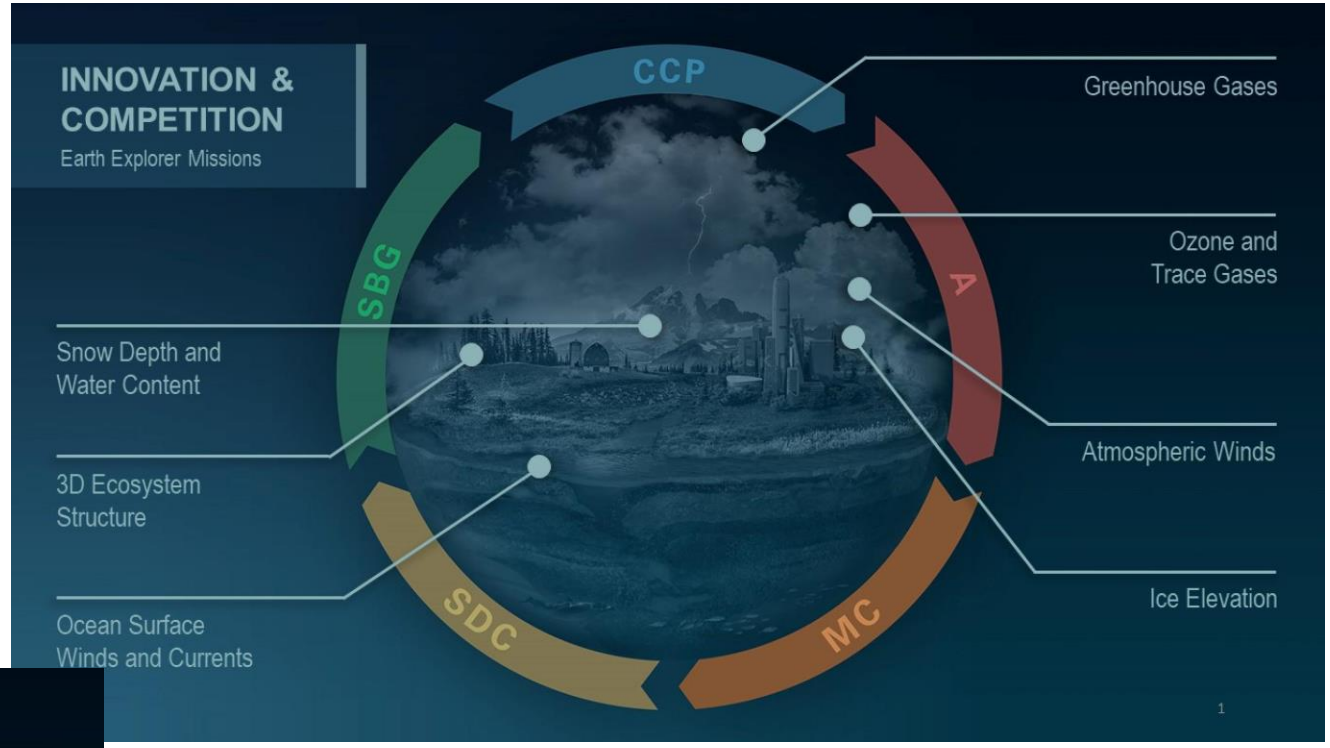
Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats (TROPICS)

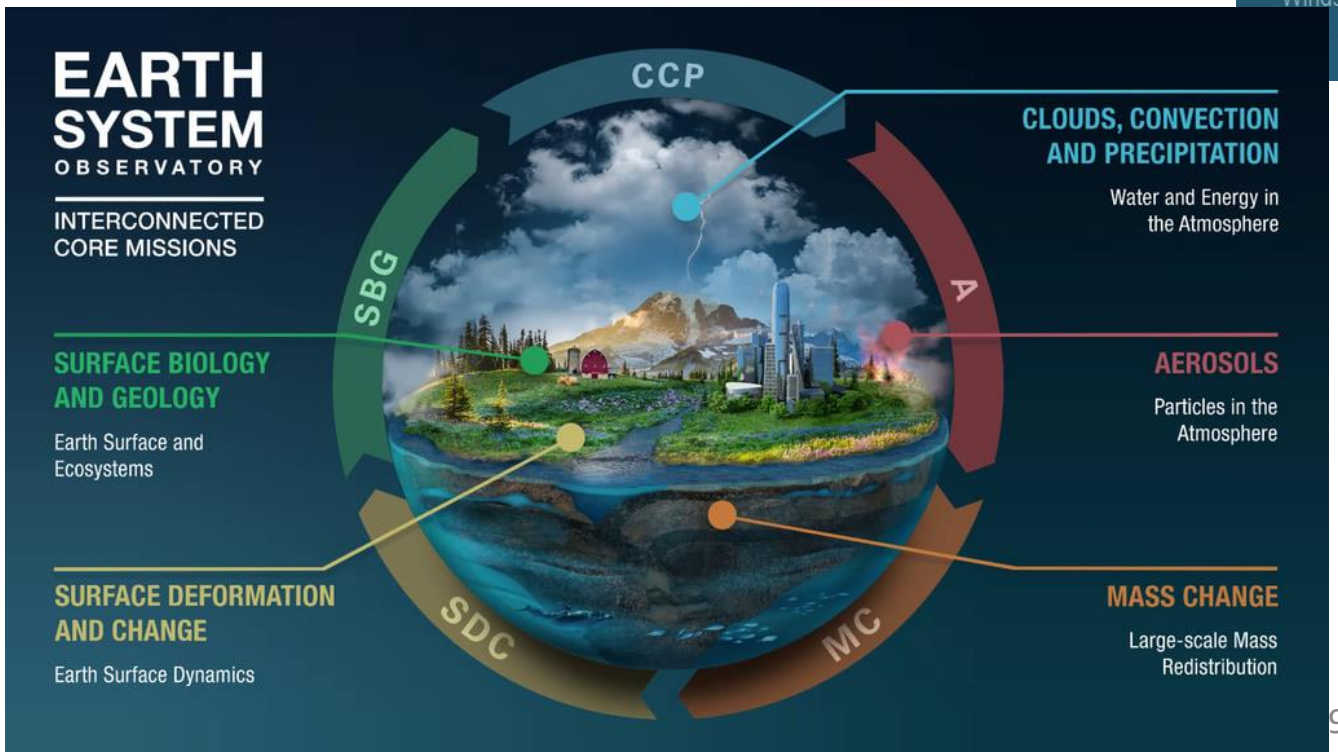
Microwave sounder



Earth System Observatory

Core Designated Observable Missions

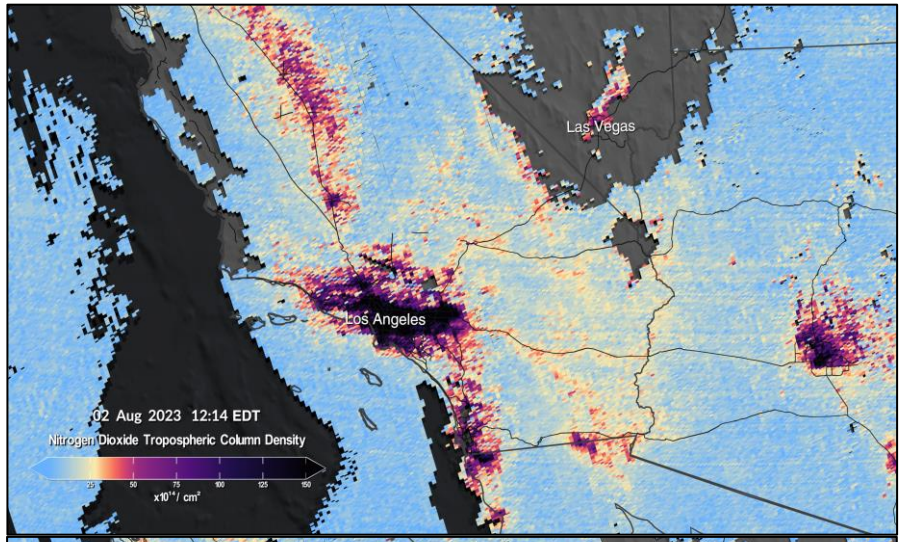


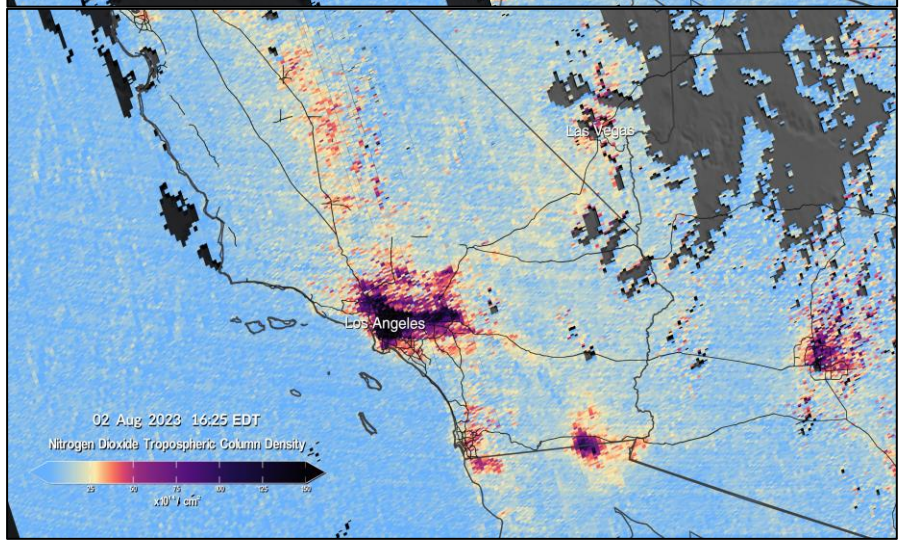


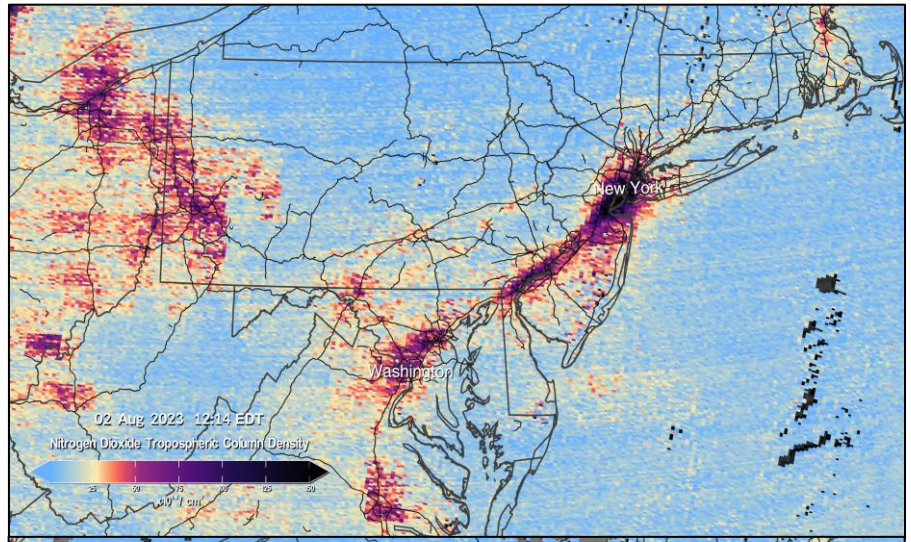
Earth System Explorer Proposals submitted August 2

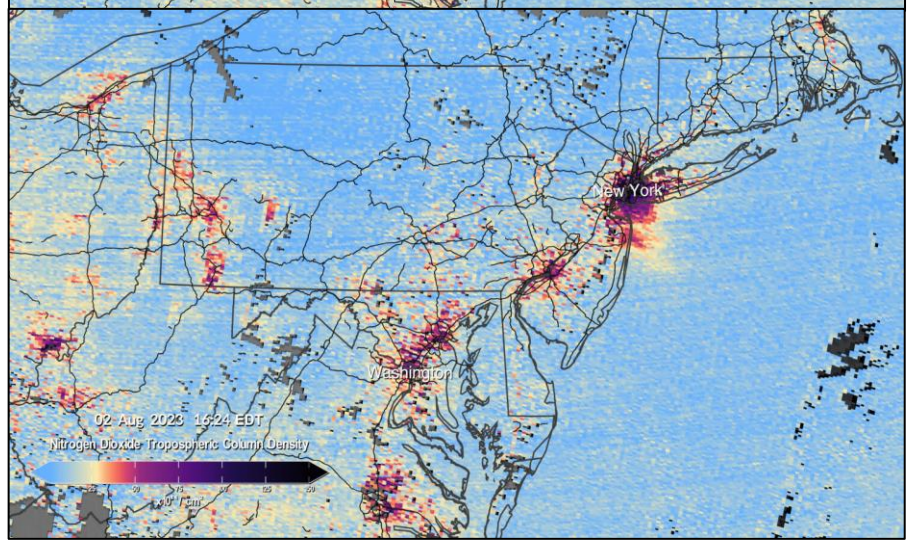
NASA TEMPO: Tropospheric Emissions: Monitoring of Pollution

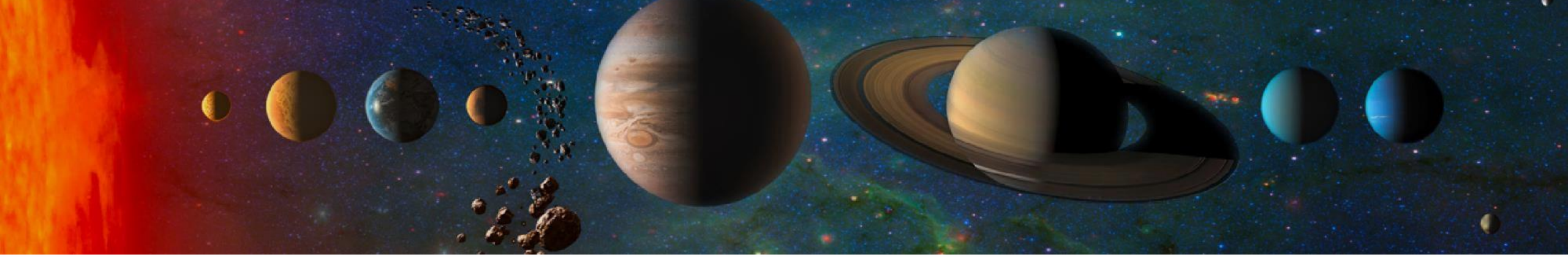
- PI Kelly Chance, Smithsonian Astrophysical Observatory
- Spectrometer
  - ozone,
  - **nitrogen dioxide,**
  - formaldehyde,
  - aerosols,
  - water vapor,
  - several trace gases











Planetary Science Advisory Committee (PAC) Report

Serina Diniega, PAC Chair

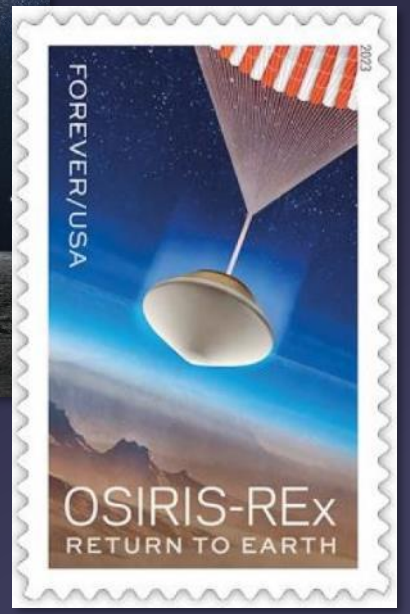
August 30, 2023

NASA Advisory Council Science Committee

NASA HQ

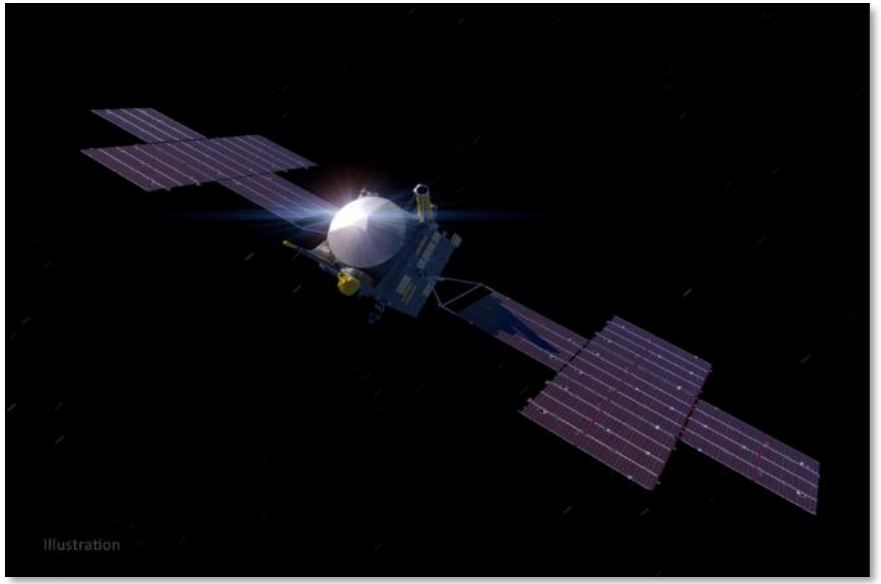
OSIRIS-REx

- Sample capsule lands **10:55 am EDT, September 24, 2023**, at the Utah Test and Training Range (UTTR)
- Estimate **~250 grams** (±100 g) of material was collected
- Capsule will be retrieved by helicopter and taken to a UTTR pop-up clean room for a preliminary checkout
  - Capsule and contents will be flown to JSC on September 25, 2023
- Once samples are delivered, **OSIRIS-APEX** mission will begin, while OSIRIS-REx sample analysis campaign begins
- New USPS stamp will be released to honor OSIRIS-REx



Psyche

- Launch period: **October 5–25, 2023**
  - Arrives at Psyche August 2029
- ATLO 2.0 began June 6, 2023!
- JPL working closely with project to maintain level of experienced staff to complete remaining work prior to launch
- Status DPMC held February 2023: Phase-E cost profile approved
- IRB out brief DPMC held May 30, 2023
  - Final report media briefing held June 5, 2023
- KDP-E scheduled for September 14, 2023



Commercial Lunar Payload Services (CLPS)

Astrobotic Peregrine Mission 1

Launch date awaiting ULA/Vulcan-Centaur

7 NASA Payloads from 5 Centers

Astrobotic will deliver VIPER in 2024

Intuitive Machines Nova-C

Launching Q3 2023

5 NASA Payloads from 3 Centers

6 Non-NASA payloads

Intuitive Machines PRIME-1

Launching November 2023

Lunar Trailblazer (SIMPLEx) rideshare

Europa Clipper

- ATLO is continuing: live feed from High Bay
- Message in a Bottle campaign launched
  - New poem from U.S. Poet Laureate will be inscribed on chip on spacecraft
  - Send your name: go.nasa.gov/MessageInABottle
- All ten instruments have been delivered!
  - REASON antennae and ECM boom not yet delivered, but electronics are
  - Most instruments are installed in the spacecraft
- Spacecraft stacked into final flight configuration week of June 12
- Target launch: October 2024
- Jupiter Orbit Insertion: April 2030

Message in a bottle campaign

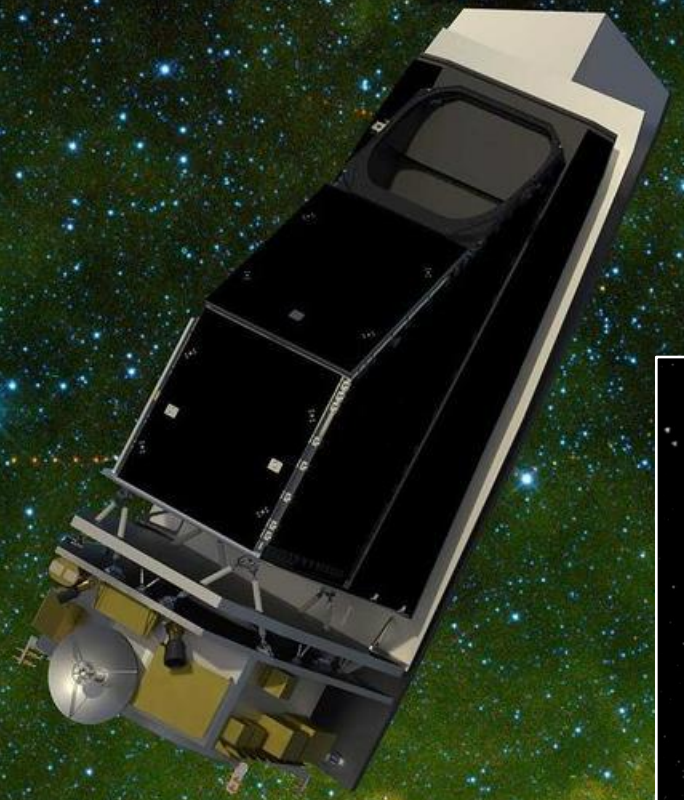
Installation of 2-ft-wide reaction wheels on main body of spacecraft

Slide from Lori Glaze, August 2023

NEO Surveyor

Space-based infra-red telescope designed for NEO detection, tracking, and characterization

- Passed KDP-C and entered Phase C, November 2022
- Instrument subsystem-level Critical Design Reviews started in 2023
- On track to launch no later than June 2028



Announcements for the PAC

General PAC meeting schedule: Spring (Feb/Mar; hybrid ~2days), Summer (Jun/Jul; hybrid ~3days), Winter (Nov/Dec; virtual ~2days)

Held PAC meeting June 21-23

Next PAC meeting will be November 13-14

- Last meeting for ~3 members, including me

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

Findings (abbreviated) from: June 21-23, 2023

1) The PAC recognized the high degree of uncertainty regarding federal government budgets in the coming years, impacting planning for planetary work. The PAC endorsed the **budget priorities** that were presented by PSD:
   i. to protect/grow R&A to at least 10% of PSD budget (= the OWL Decadal recommendation);
   ii. support ongoing and confirmed (Phase C) missions;
   iii. support missions that have been selected and are currently in Phase B, including restarting VERITAS;
   iv. after current firm commitments are addressed, new starts and AOs would be initiated.

   The PAC also recommended that:
   i. PSD adopt the OWL recommendations for MSR and future MEP missions, including cost limits.
   ii. PSD provide regular reports on the MSR project status to the PAC and the community, including results of the current Independent Review Board (IRB) for MSR, and to hear about specific mechanisms planned for MSR cost management.
   iii. PSD provide early study funds, budget permitting, for the Uranus Orbiter and Probe and Lunar Endurance Rover so as to keep these Decadal-prioritized concepts maturing.
   iv. funding of extended missions at levels recommended by Senior Review evaluations.

Full text of Findings and Meeting Minutes: https://science.nasa.gov/researchers/nac/science-advisory-committees/pac

Findings (abbreviated) from: June 21-23, 2023

2) The PAC agreed with PSD's proposed **new elements for the R&A program, starting in FY25 (budget-permitting),** that aim to broaden participation in planetary science and create a more diverse and inclusive planetary science community: (1) mission concept studies, (2) postdoctoral fellowship program, and (3) studies to explore approaches to improving/broadening participation in planetary science with eventual embedding of these approaches through all PSD programs*.

*see upcoming slide

3) The PAC supported development of a **new fieldwork policy**, that has been developed by the PSD Astrobiology Program/ROSES with indigenous scientists and groups, to raise awareness of ethical responsibilities and related legal requirements for fieldwork. The PAC encouraged continued dissemination of related resources and guidance, in particular to those involved with fieldwork and terrestrial or planetary sample collection and analysis.

4) The PAC appreciated recent improvements in **Inclusion Plan requirement definition and communications** and encouraged continued improvements.

5) The PAC appreciated the work done by JPL to **address issues identified by the Psyche IRB** and requested an update on the Agency's internal reviews of the SRB review process and the Agency's response to the IRB recommendations.

Full text of Findings and Meeting Minutes: https://science.nasa.gov/researchers/nac/science-advisory-committees/pac

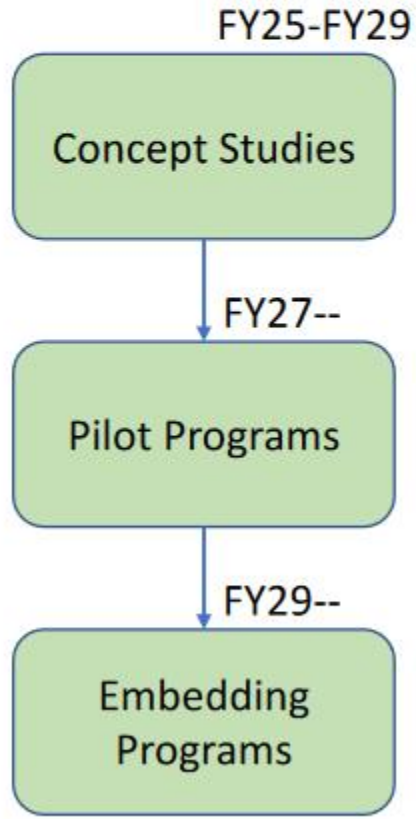
FY25 New Programs: Mission: IDEA

Why?

- Decadal white papers showed that there are ideas
  - Need to mature ideas to include implementation plans and metrics for success
- Encourage collaboration across disciplinary boundaries and across diverse communities
- Provide funding for people doing the heavy lifting

The (tentative) plan:

- The goal is to have proposals led by social scientists with participation from the planetary science community.
- Provide significant funding for concept studies that will explore approaches to improving participation in planetary science
- Focus on IDEA activities that can be embedded, not siloed
- Downselect some studies to become actual pilot programs



Next meeting: Nov 13-14, 2023

Status Reports

- Planetary Science Division (PSD) Update
- Mars Exploration Program (MEP)/Mars Sample Return (MSR) Updates
- Community Analysis/Assessment Groups
- R&A Update
- Planetary Defense (PDCO)
- Astrobiology & Research Coordination Network (RCN) Updates
- ESSIO/Lunar Science Update

Specific Topics (all tentative - TBC)

- SRB review process
- MSR IRB Report
- …

HPAC/SWC

Space Weather Council

UPDATE TO THE NASA SCIENCE ADVISORY COUNCIL SCIENCE COMMITTEE

Nicole Duncan, SWC Chair & Ball Aerospace

*** All opinions expressed are my own

May 2023

No HPAC meetings were held since November 2022

- HPAC is going through major re-organization, several members ended their terms, new members are coming onboard soon!
- Current members:
  - Aroh Barjatya
  - Paul Cassak
  - Matina Gkioulidou
  - Nicole Duncan (automatic as Chair of Space Weather subcommittee)
- NASA have received acceptances for all the HPAC nominees, which gets the roster to 14 total committee members.

Space Weather Council (SWC)

- SWC acts as a community-based forum to coordinate community input and provide advice to NASA HPD via HPAC
- SWC is a FACA subcommittee to HPAC, and is responsive to actions levied by its parent organization
  - SWC Chair: Nicole Duncan
  - SWC Designated Federal Officer: Kelly Korreck
  - SWC Members: Janet Green, Michele Cash, Angelos Vourlidas, Piyush Mehta, Ron Turner, Alexa Halford, Paul O'Brien, Dan Baker and Sage Andorka
- **The HPAC provided the SWC four tasks in August of 2022**. The SWC convened with invited speakers and discussed these tasks in August 2022 and May 2023.
- HPAC provided overview of SWC updates to NAC in May 2023

Task 1: Coordination between SWx groups

- **SWC is advised to research the activities of SWORM and SWAG, identify overlaps and gaps, and determine how SWC can complement and leverage ongoing efforts**, with specific relevance to the interests of the NASA Heliophysics Division.
  - This may include researching reports on the committee websites; attending their public meetings; organizing a meeting of committee chairs and staff; and defining how the role of the SWC can complement the work of these existing committees.

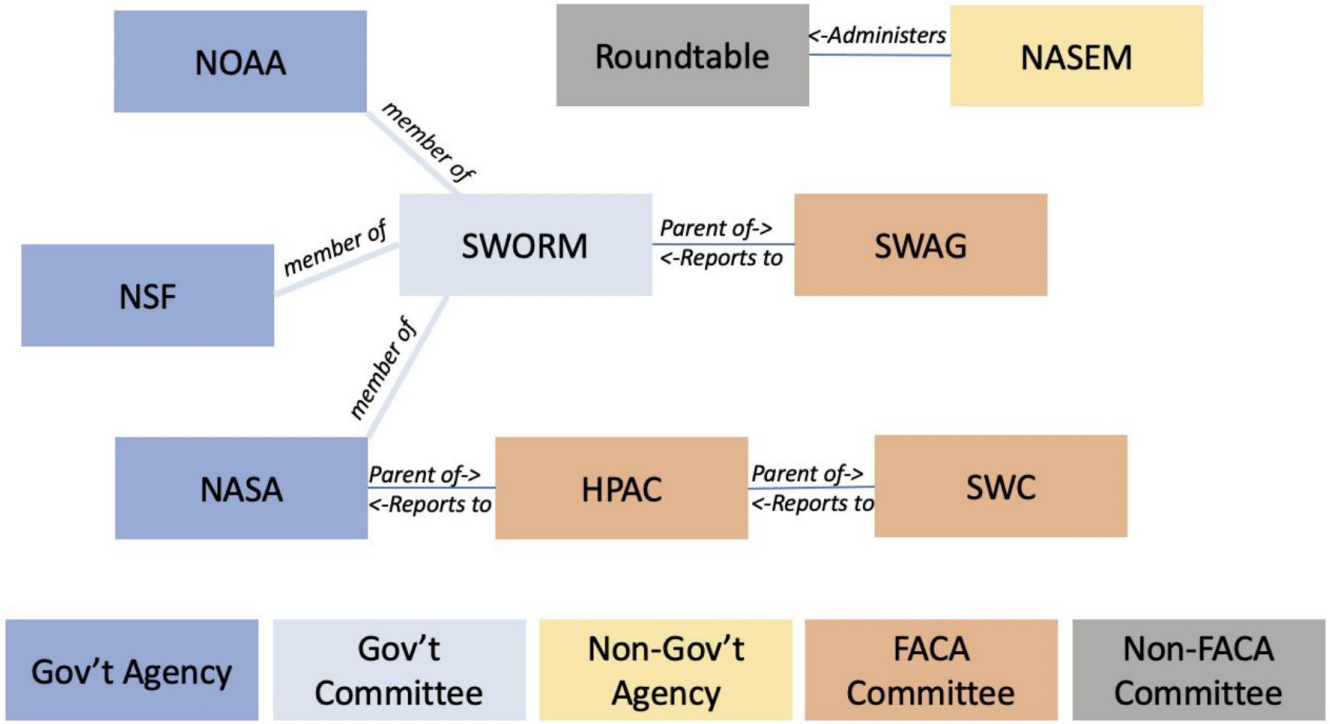
Overview of committees

- SWORM: Interagency working group led by the White House, composed of government agency representatives including FAA, NASA, NOAA, DOE, DHS, NSF, USGS, and the DOD.
- SWAG: Provides recommendations and findings to the SWORM who can then implement those recommendations into agencies plans. Consists of 5 academia, 5 commercial space weather, and 5 user group members.
- Roundtable: Brainstorming group that generates ideas but no written suggestions or recommendations. Ideas generated by the Roundtable may be considered by other groups to inform policy decisions.
- SWC: Gives tactical advice to NASA on its space weather program. Responds specifically to tasks given from the Heliophysics Advisory Committee.

Reporting structure

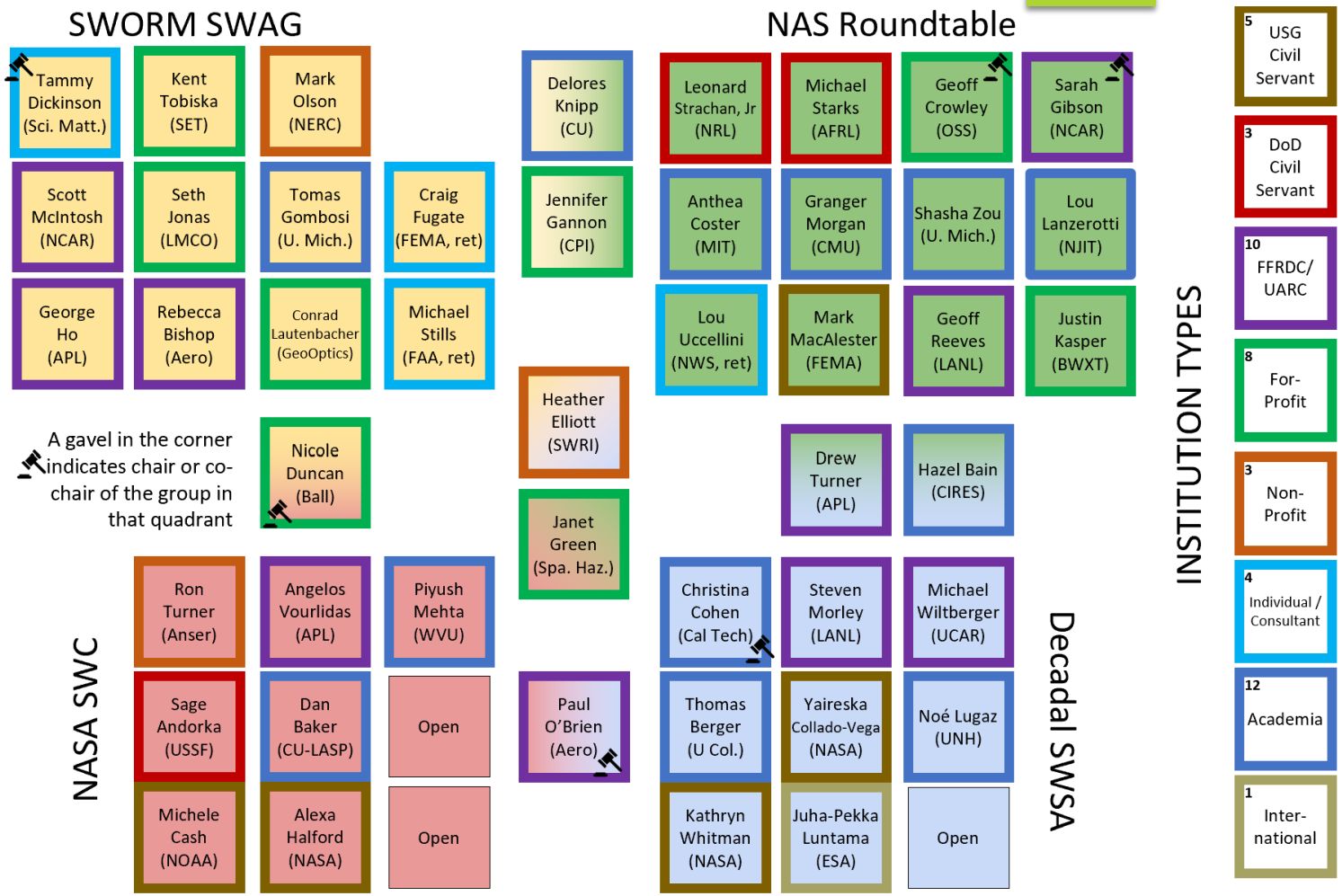
- The groups focus on related but independent topics and tasks.
- Each have different mechanisms for communicating findings to agencies for consideration and possible implementation.

Flow chart depiction how the groups interact



Overview of Committees

- Including Decadal Space Weather panel
- Cross-membership provides continuity and context
- SWC provided a summary of highlights from SWAG, SWORM and Roundtable to HPAC



Findings

- SWC views successful coordination and communication between the groups as an opportunity to address the greater national/international space weather needs and ensure a strong and effective global Space Weather Enterprise

- Coordination between the groups has been successfully achieved with regular tag-ups between the leads, invitations to present and participate in each others meetings, and overlapping members within the groups sharing ideas.

- SWC will improve coordination by:
  - Sharing the specific tasks assigned by the HPAC with the other groups when they are received
  - Asking other groups to notify the SWC when they address topics specifically related to NASA

Highlights

- Highlights from SWAG, SWORM and Roundtable relevant to HPAC were provided:
  - Lessons learned and best R2O2R (research to operations to research) practices.
  - Benefits from free and open exchange of data related to the impacts of space weather on technological systems operated by the commercial, academic, and governmental sectors.
  - Recommendations for increasing sensor deployments with opportunistic missions and required sensors on all government vehicles.
  - Coordination between space-based monitoring projects and exploratory missions with agencies responsible for ground-based monitoring.

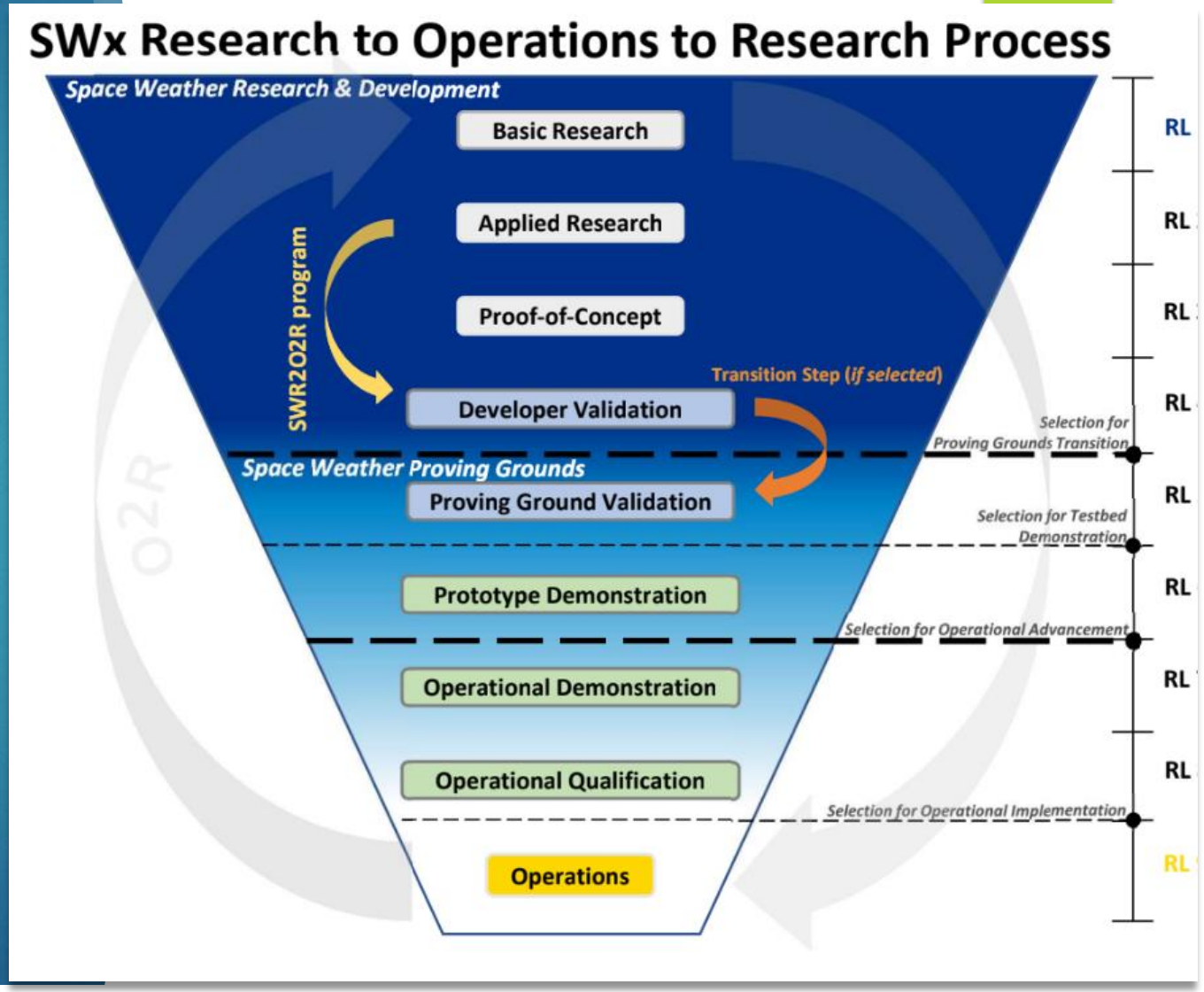
Task 4: Coordination between agencies

- The SWC is advised to work on the development of **specific suggestions for interagency NASA-NOAA-NSF-DoD cooperation** in order to maximize return on investment in research infrastructure supported by agencies. Specific examples include development of suggestions about better coordination between NASA and NOAA supported space-based instruments and NSF-supported ground-based infrastructure, data fusion from multiple instruments, data assimilation efforts, etc.

Extensive R2O2R discussion

- Examined inter-agency coordination in SWSA AOs and decisions

- Recommended for consideration
  - Intentionality of overall lifecycle
  - Transparency on the process for selecting capabilities for transition
  - Improved definition of the transition process, especially as regards maturity at handoff to the receiving (operational) organization
  - Enhanced Funding
  - Defining and expanding role of non-government providers and users in framework



Task 4 Response: Roles & Responsibilities

- Investigate developing a single location to collect current and historical interagency space weather data.
  - Also highlighted in NASA Space Weather Gap Analysis and SWAG Report
- Explore the Unified Data Library as a pathway to obtain DoD data.
- Develop a comprehensive contact list of international partners including roles and responsibilities.
- Request to HPAC for future work:
  - Explore NASA-NSF collaboration opportunities, including the new NSF Technology Innovation and Partnerships (TIP) program, the Decadal Survey's output, and joint funding

Thank you

NICOLE DUNCAN

NICOLE.DUNCAN@BALLAEROSPACE.COM

Task 2: Space Weather Gap Analysis

- Of specific interest to the HPD and HPAC is an analysis of the gaps in space weather fundamental science, modeling and impacts. **Gap analysis studies have been performed by different agencies within the last decade, and a summary review of this material is of importance for HPD future plans.**
  - Specifically, the HPD supports development of a range of instruments at different technology readiness levels. Up-to-date understanding of knowledge gaps will assure that HPD can make an informed decision in prioritizing development of certain technologies, instruments, and models.

- Reviewed NASA Space Weather Gap Analysis, NASEM Phase I & II Space Weather Workshops.

Task 2 Recommendations

- Explore approaches to quantify the return-on-investment from filling a gap.

- There has not been a gap analysis which considers the needs of space weather analysts in support of human exploration (Task 3 focus). SWC identified the urgent need for a comprehensive SEP gap-filler analysis (especially with the Artemis program underway).

- Consider undertaking a modeling gap analysis. Two important gaps identified:
  a. Long-term, multi-event historical reanalysis – valuable tool for extreme values and for model validation.
  b. Extreme events cannot be modeled with the routine models – dedicated models for extreme events are needed.

Task 3: ARTEMIS and Space Biology

- The SWC is advised to address the NASA's Artemis and space biology programs to determine the potential to extend our knowledge with lunar focused space weather measurements and studies.

Task 3 Recommendations

- Continue and enhance collaborations across NASA directorates, NASA centers, agencies, and countries for Artemis.
  - It is unclear, however, who takes responsibility once commercial crewed missions begin. This may be a discussion for SWAG.
- Include, pursue, explore, and leverage SWx instrument opportunities on board Artemis infrastructure and opportunistic platforms as these arise.
- Explore and pursue areas where NASA can share cost, reduce risks and perform enabling tasks (such as anomaly resolution) more effectively with the addition of space weather assets.
- Encourage existing missions and modeling efforts to provide their data and capabilities to the Moon2Mars Space Environment office (and others) to perform validation.

Astrophysics Advisory Committee Update

Upcoming Meetings

- Fall Meeting: October 19 – 20, 2023

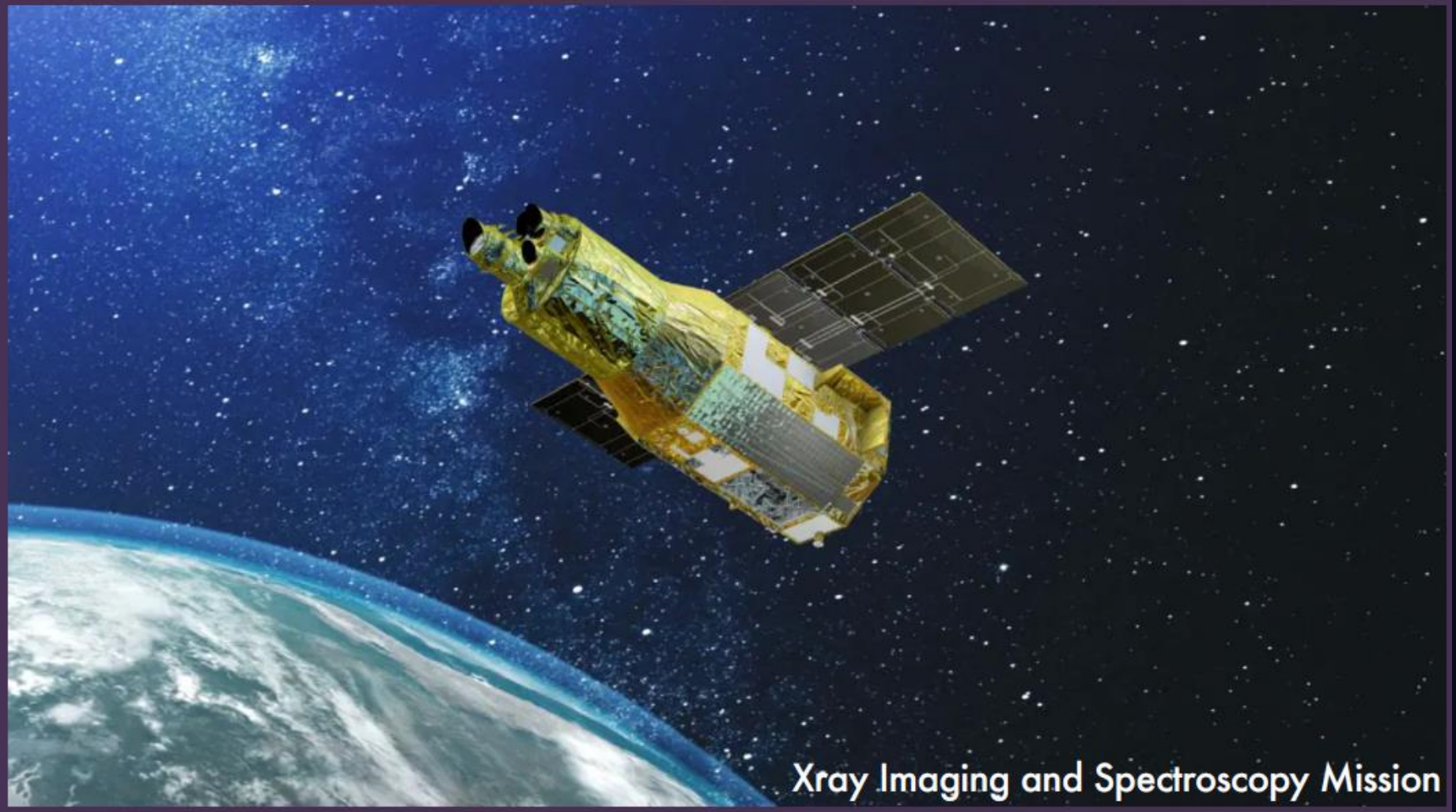
APAC Members

- 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
- Ryan Hickox – Dartmouth College
- Shirley Ho – Flatiron Institute
- Shardha Jogee – University of Texas, Austin
- Alina Kiessling – Jet Propulsion Laboratory
- Mark Mozena – Planet Labs Inc.
- Ilaria Pascucci – University of Arizona
- Grant Tremblay – Harvard-Smithsonian Center for Astrophysics

July 1st: SpaceX launches Euclid, joint ESA/ NASA mission to explore the ‘dark universe’


Commissioning image from Near Infrared
Spectrometer and Photometer (contributions from NASA)

JAXA-led XRISM launch imminent (scrubbed 8/28/23 due to weather)



APAC Meeting Documents

June 27 - 28, 2023

- Letter from the Chair Kelly Holley-Bockelmann: August 14, 2023
- Meeting Minutes: June 27-28, 2023
- Agenda: June 27-28, 2023
- Federal Register Notice: June 27-28, 2023
- Presentations
  - Astro Update - M. Clampin
  - COPAG Report - S. Nikzad
  - ExoPAG Report - I. Pascucci
  - PhysPAG Report - J. Finke
  - Swift Update - B.Cenko
  - TDAMM Update - V. Connaughton
  - NuSTAR Update - B. Grefenstette
  - GOMAP Update - S. Domagal-Goldman
  - Fermi Update - E. Hays
  - First Science Results from IXPE - P. Kaaret
  - Roman Update - J. McEnery
  - OpenScience - R. Ojha

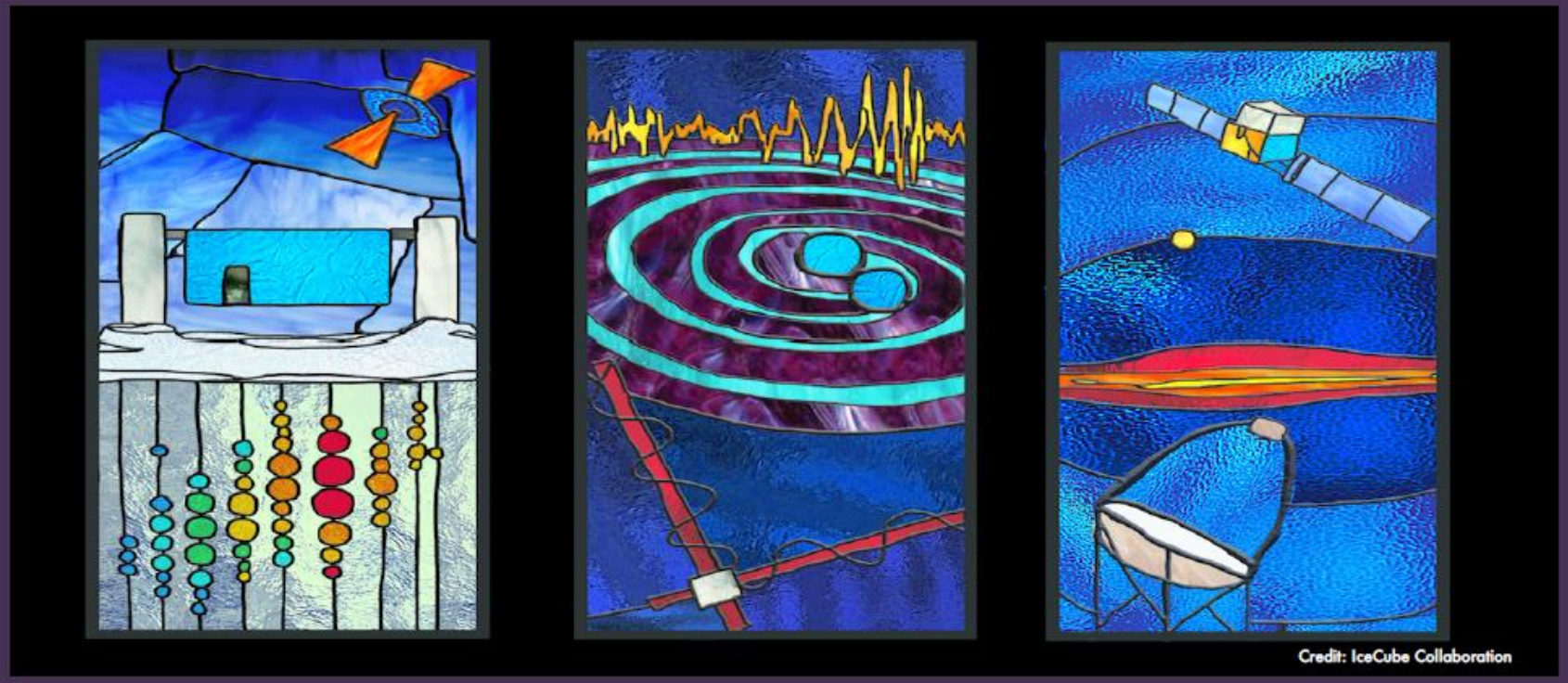
June focus:

Time Domain and Multimessenger Astronomy

Open Science

Great Observatories Maturation Program

Time Domain and Multimessenger Astronomy (TDAMM)



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

TDAMM Approach in APD

PhysCOS/COR hosted TDAMM workshop, issued White paper, created new cross-PAG SAG

Infrastructure investment (DSN, centralized alert/ followup, coordination with NSF, MMA software)

Recasting current fleet as TDAMM missions

March:
TDAMM-related findings and recommendations

The APAC commends the attention given to bolstering infrastructure and space communications in general and to enable TDAMM. However, the APAC found the APD working interpretation of TDAMM to be at once too broad (a mission detecting transients) and too narrow (a mission for prompt electromagnetic followup of ground-based gravitational wave alerts). The lack of TDAMM prioritization and strategy puts the rich discovery space of this emerging field at risk.

The APAC is concerned about the level of priority and funding given to TDAMM. The update noted that TDAMM funding, including precursor science, was $5M in FY23, far below the Astro2020 recommended funding in this decade.

The APAC recommends higher prioritization of TDAMM. As a first step, APAC recommends a reanalysis of APD's current portfolio to determine how to maximize TDAMM capabilities, such as prioritizing TDAMM in mission selection or enabling TDAMM science through multi-messenger joint analysis tools in TDAMM-specific ADAP opportunities.

June:
TDAMM-related findings and Recommendations

The APAC appreciates the excellent work being done in TDAMM by Fermi, Swift, and NuSTAR. However, there is a concern that the portfolio of missions is aging and that there is no clear plan or strategy to maintain a TDAMM fleet moving forward. It is not sufficient to say that future small missions will be capable of TDAMM science. It is important to be intentional and strategic about how the TDAMM missions will work together.

In particular, the APAC understands that the current budget climate is not conducive to adding a large TDAMM-specific mission to the portfolio; it is for precisely this reason that APD needs to analyze the consequences of this decision on NASA's ability to address the science questions prioritized in the Decadal, to develop a mitigation plan for the aging fleet on TDAMM capabilities, and to prepare a long-term strategy to prioritize TDAMM within the budget profile.

The APAC recommends APD to develop a mitigation plan for the aging fleet on TDAMM capabilities and to prepare a long-term strategy to prioritize TDAMM within the budget profile, including cross-agency and international partnerships as well as prioritization within R+A.

Thanks!

Astrophysics Analysis Groups

Cosmic Origins Program Analysis Group (COPAG)

"How did we get here?" This program comprises projects that enable the study of how stars and galaxies came into being, how they evolve, and ultimately how they end their lives. The Hubble Space Telescope, Spitzer Space Telescope, and the Stratospheric Observatory For Infrared Astronomy (SOFIA) all address central questions of the Cosmic Origins Program. NASA's next flagship observatory, the James Webb Space Telescope (JWST) is the major new component of this program.*

**As of December 2010, JWST is managed and funded by its own Office separate from the Astrophysics Division.*

Exoplanets Program Analysis Group (ExoPAG)

ExoPAG is responsible for soliciting and coordinating community input into the development and execution of NASA's Exoplanet Exploration Program (ExEP). The ExoPAG serves as a community-based, interdisciplinary forum for analysis in support of activity prioritization and for future exploration. It provides findings of analyses to NASA through the NASA advisory Council within which the ExoPAG Chair is a member of the Astrophysics Subcommittee.

Physics of the Cosmos Program Analysis Group (PhysPAG)

PhysPAG serves as a forum for soliciting and coordinating input and analysis from the scientific community in support of the Physics of the Cosmos program objectives. The PhysPAG enables direct and regular communication through public meetings that give the community opportunities to provide its scientific and programmatic input.

NASA Advisory Committee
Science Committee
Summer Meeting
Aug 2023

Will Resume Soon

National Aeronautics and Space Administration

HELIOPHYSICS BIG YEAR

Dr. Therese Jorgensen

Acting Deputy Director,

SMD Heliophysics Division

NASA Advisory Council Science Committee
30 August 2023

National Aeronautics and Space Administration

HELIOPHYSICS BIG YEAR

Dr. Gina DiBraccio

Deputy Director, Heliophysics Science Division

Goddard Space Flight Center

NASA Advisory Council Science Committee
30 August 2023

gina.a.dibraccio@nasa.gov

UPCOMING SOLAR ECLIPSES

Annular Solar Eclipse

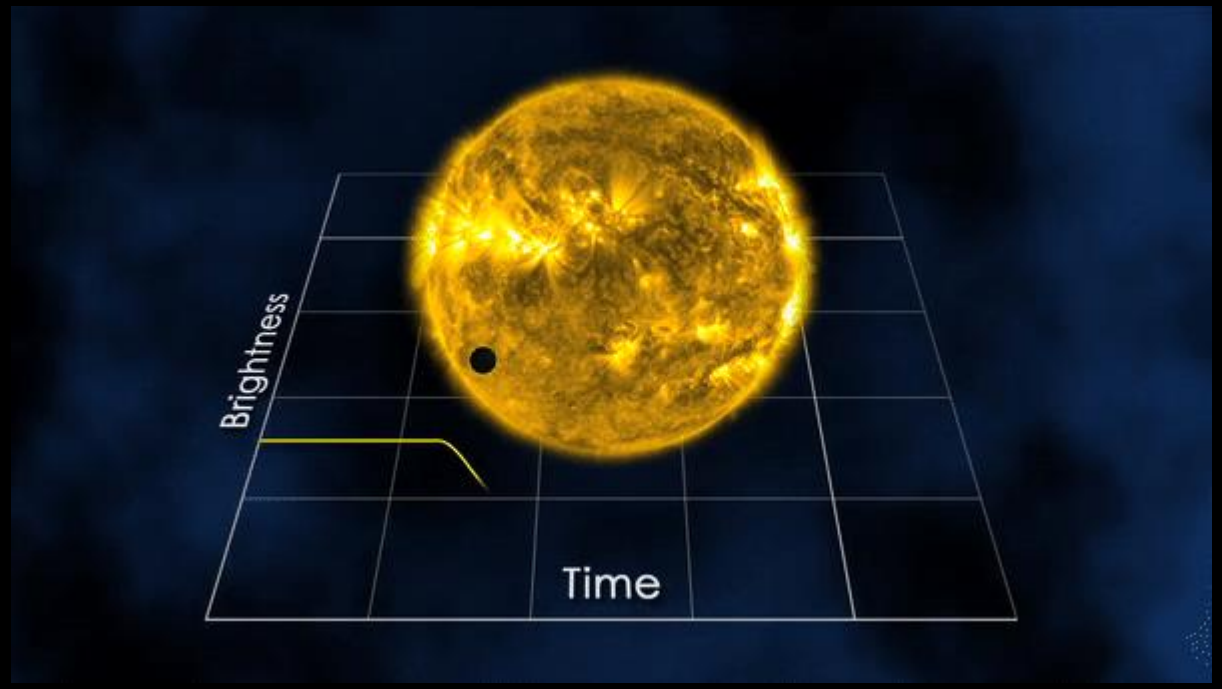
Total Solar Eclipse

https://solarsystem.nasa.gov/eclipses/

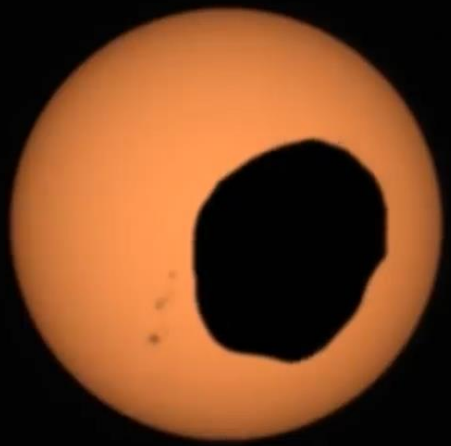

eclipse
THROUGH THE EYES OF NASA
NASA
2023 Maximum Partial Obscuration (%)
2024 Maximum Partial Obscuration (%)
2023 Annular Solar Eclipse
2024 Total Solar Eclipse
9:15 AM PDT
9:20 PDT
9:25 PDT
10:30 MDT
10:35 MDT
10:40 MDT
11:45 CDT
11:50 CDT
12:25 CST
12:20 PM CST
1:30 CDT 12:30 CST
1:35 CDT
11:55 CDT
12:00 CDT
12:05 PM CDT
1:40 CDT
1:45 CDT
1:50 CDT
1:55 CDT
2:00 CDT
2:05 CDT 3:05 EDT
3:10 EDT
3:15 EDT
3:20 EDT
3:25 EDT
3:30 EDT
4:35 PM ADT
Pacific Ocean
Atlantic Ocean
Gulf of Mexico
CANADA
UNITED STATES
MEXICO
Seattle
Portland
San Francisco
Sacramento
San Jose
Fresno
Bakersfield
Los Angeles
Long Beach
San Diego
Las Vegas
Phoenix
Mesa
Tucson
El Paso
Albuquerque
Denver
Colorado Springs
Aurora
Wichita
Kansas City
Omaha
Chicago
Milwaukee
Detroit
Minneapolis
St. Paul
St. Louis
Cincinnati
Indianapolis
Columbus
Cleveland
Pittsburgh
Philadelphia
New York
Boston
Baltimore
Washington D.C.
Nashville
Memphis
Atlanta
Charlotte
Jacksonville
Orlando
Tampa
Miami
New Orleans
Houston
Dallas
Ft. Worth
Austin
San Antonio
Oklahoma City
Tulsa
Lexington
Louisville
Raleigh
Virginia Beach
The 2023 & 2024
Solar Eclipses
through the eyes of NASA
Lunar topography data from NASA's Lunar Reconnaissance Orbiter and the Japan Aerospace Exploration Agency's SELENE lunar orbiter were used to precisely calculate the location of the Moon's shadow for the 2023 and 2024 solar eclipses. The planetary positions are from NASA's Jet Propulsion Laboratory Development Ephemeris 421. Earth imagery from NASA's Blue Marble: Next Generation series were used to create the terrain and Earth at night imagery from NASA's Black Marble were used under the eclipse paths.
2023 Annular Solar Eclipse
Saturday, October 14, 2023
2024 Total Solar Eclipse
Monday, April 8, 2024
Credit: Michala Garrison and the Scientific Visualization Studio (SVS), in collaboration with the NASA Heliophysics Activation Team (NASA HEAT), part of NASA's Science Activation portfolio
Eclipse calculations by Ernie Wright, NASA Goddard Space Flight Center
0 mi 200
0 km 200
2023 Path of Annularity October 14, 2023
Along a path about 125 miles wide, the Sun will appear as a "ring of fire" in the sky. Annularity lasts up to 5 minutes depending on the viewer's location within this path.
2024 Path of Totality April 8, 2024
Along a path about 115 miles wide, the Moon will completely block the Sun in the sky. Totality lasts up to about 4 minutes and 28 seconds depending on the viewer's location within this path.
Outside of these paths, viewers within the 48 contiguous U.S. states and many other areas will see a partial solar eclipse (in the shaded areas below).
Find More: solarsystem.nasa.gov/eclipses
NP-2022-11-909-GSFC

INTERDISCIPLINARY SOLAR ECLIPSE SCIENCE

Exoplanet Transit

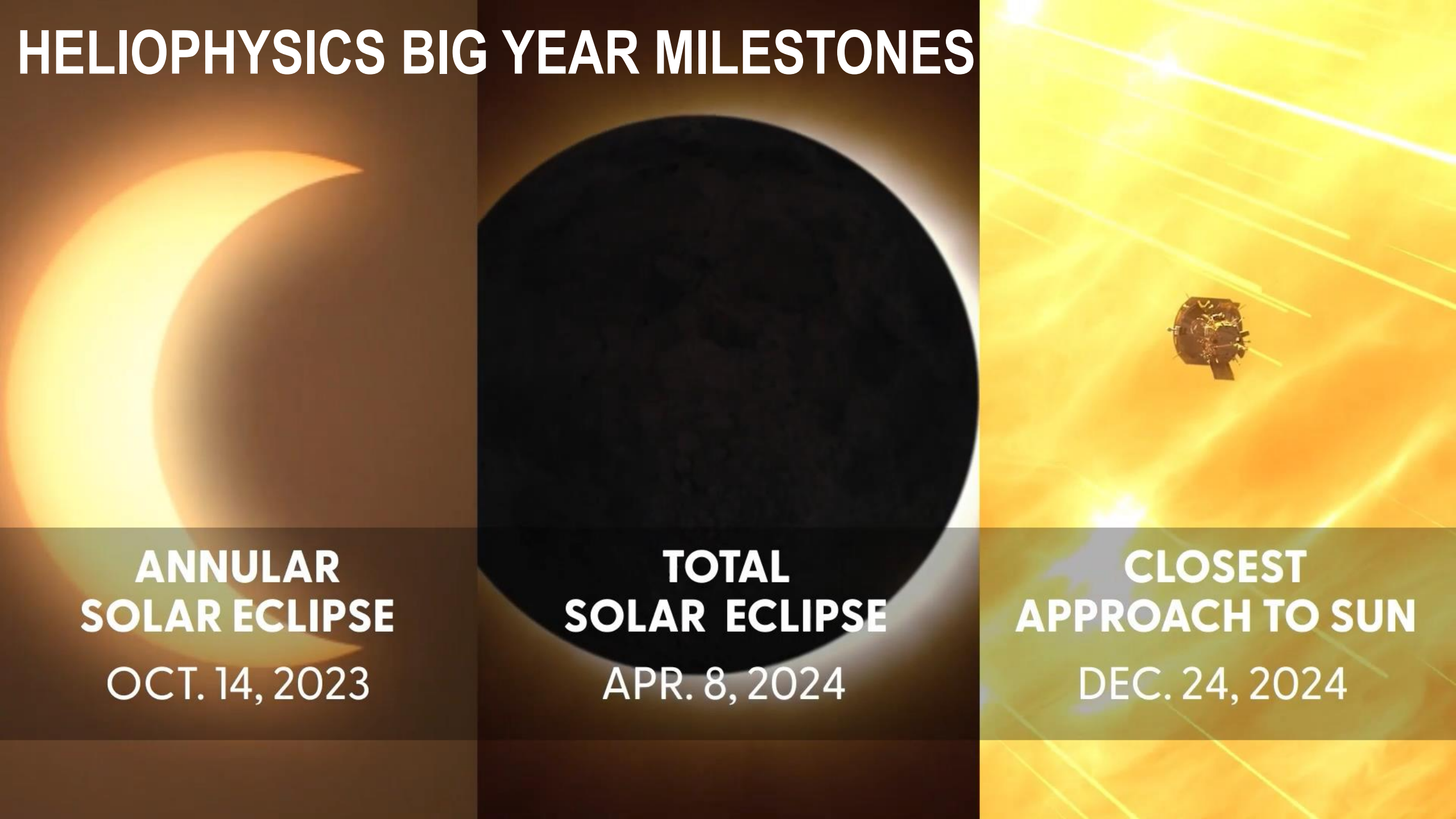


Solar eclipse viewed on Mars by NASA's Perseverance Rover



http://go.nasa.gov/HelioBigYear/

HELIOPHYSICS BIG YEAR MILESTONES



ANNULAR SOLAR ECLIPSE

OCT. 14, 2023

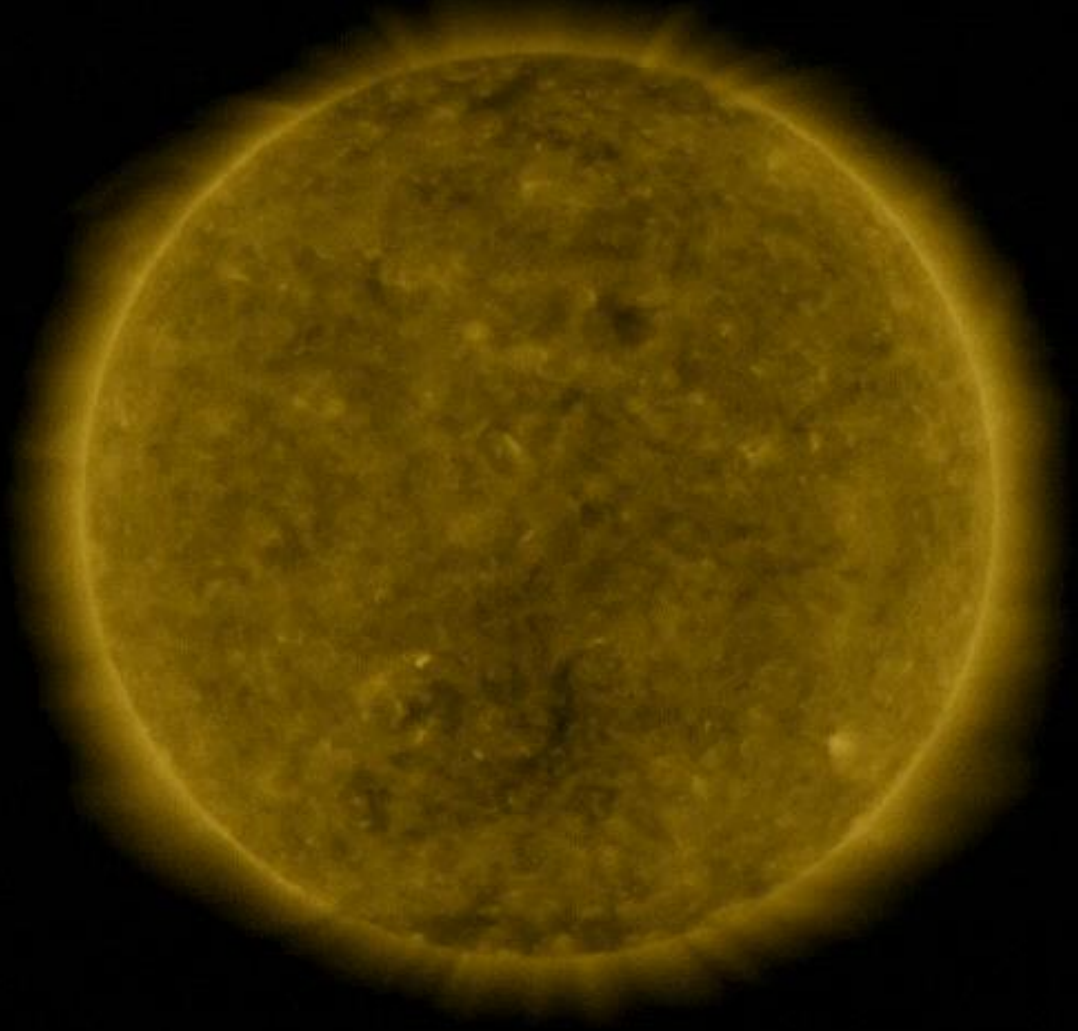
TOTAL SOLAR ECLIPSE

APR. 8, 2024

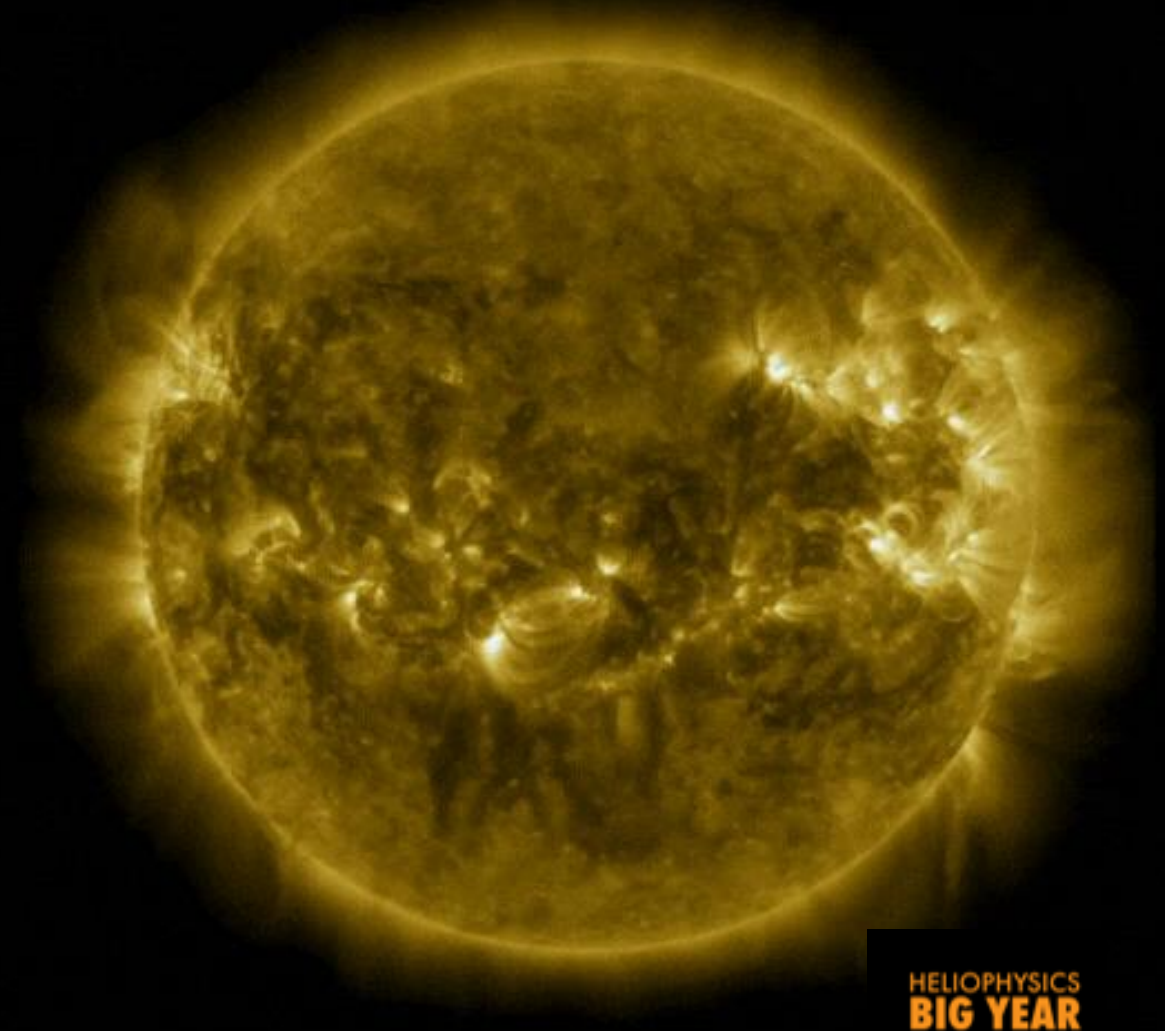
CLOSEST APPROACH TO SUN

DEC. 24, 2024

SOLAR **MINIMUM**



SOLAR **MAXIMUM**



HELIOPHYSICS
BIG YEAR

“

THE SUN TOUCHES EVERYTHING

”

HELIOPHYSICS
BIG YEAR

SOLAR ECLIPSE SCIENCE

Eclipse Chasing with NASA's High-Altitude Research Planes

- Planes will take observations with a camera that images in infrared and visible light at high resolution and high speed.
- They will study a dust ring around the Sun and search for asteroids that may orbit near the Sun.

Airborne Imaging and Spectroscopic Observations of the Corona

NASA's WB-57s will fly cameras and spectrometers, yielding insight into the constant stream of particles emitted by the Sun.

https://go.nasa.gov/3JnKx9q

HELIOPHYSICS BIG YEAR

SOLAR ECLIPSE SCIENCE

‘Listening Party’ for Amateur Radio Operators

Will record how strong and far radio signals go to observe how the ionosphere changes during the eclipse. Past experiments have shown that these changes, due to solar eclipses, have significant impacts on how radio waves travel.

Solar Radiation’s Effects on Earth’s Upper Atmosphere Layer

Will use three SuperDARN radars to study the ionosphere during the eclipse and compare the measurements to answer questions about how the ionosphere reacts to a solar eclipse.

Bringing the Sun’s Magnetic ‘Hot Spots’ Into Sharper Focus

Will use the 34-meter Goldstone Apple Valley Radio Telescope to distinguish light signals coming from one portion of solar active regions versus another. This measures changes to the radio emissions from active regions.

HELIOPHYSICS BIG YEAR

ECLIPSE SOUNDING ROCKETS

Three instrumented rockets are launching during both the annular and total solar eclipses.

Launch Sequence

- **Rocket 1:** launching ~35 minutes before peak eclipse
- **Rocket 2:** launching at peak eclipse
- **Rocket 3:** launching ~35 minutes after peak eclipse

Objectives

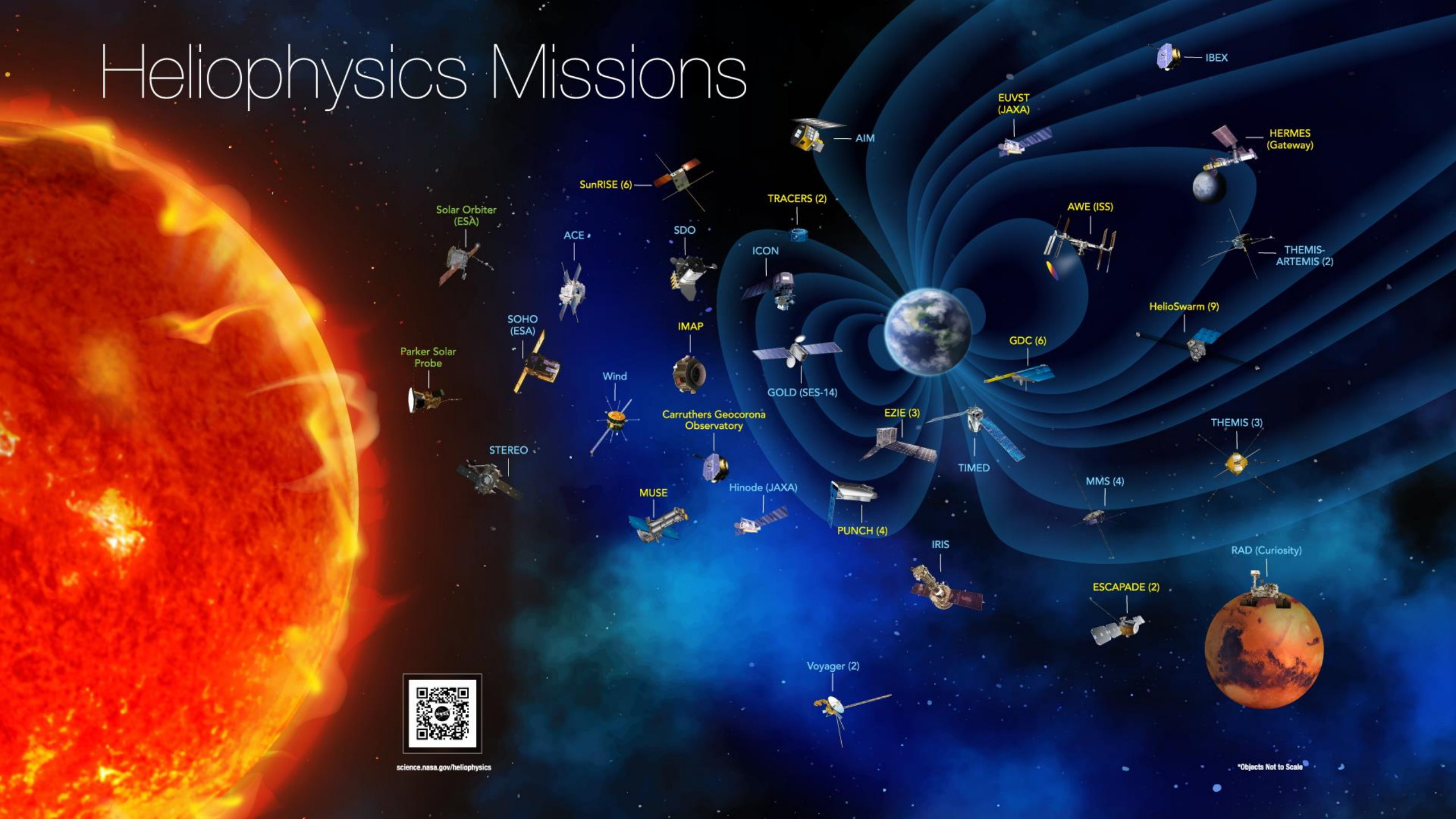
- Explore how the eclipse shadow promotes irregularities in the ionosphere
- Understand how the ionosphere responds to local changes in density, temperature, and conductivity
- Assess how lower atmosphere cooling due to the eclipse impacts ionospheric dynamics

PARKER SOLAR PROBE MILESTONES & SCIENCE

- Closest approach to the Sun in December 2024
- Launched in 2018
- Most recent Venus flyby on Aug. 21
- Touched the Sun (first measurements from within the atmosphere of a star)
- Discovered the source of magnetic switchbacks
- Helping us to understand the origin of the solar wind

bit.ly/45oXnNX

Heliophysics Missions

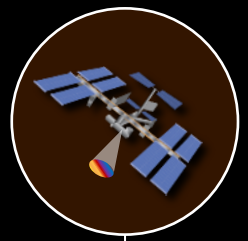
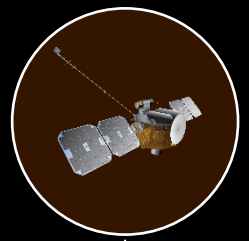
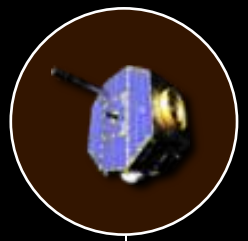
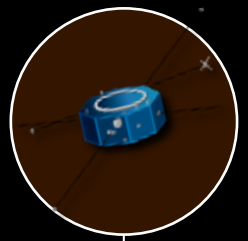
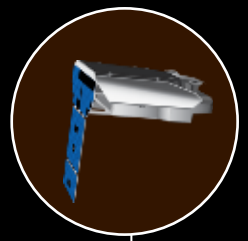
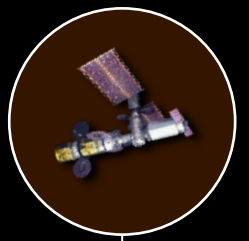
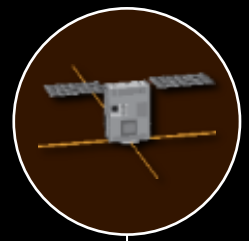


science.nasa.gov/heliophysics

*Objects Not to Scale

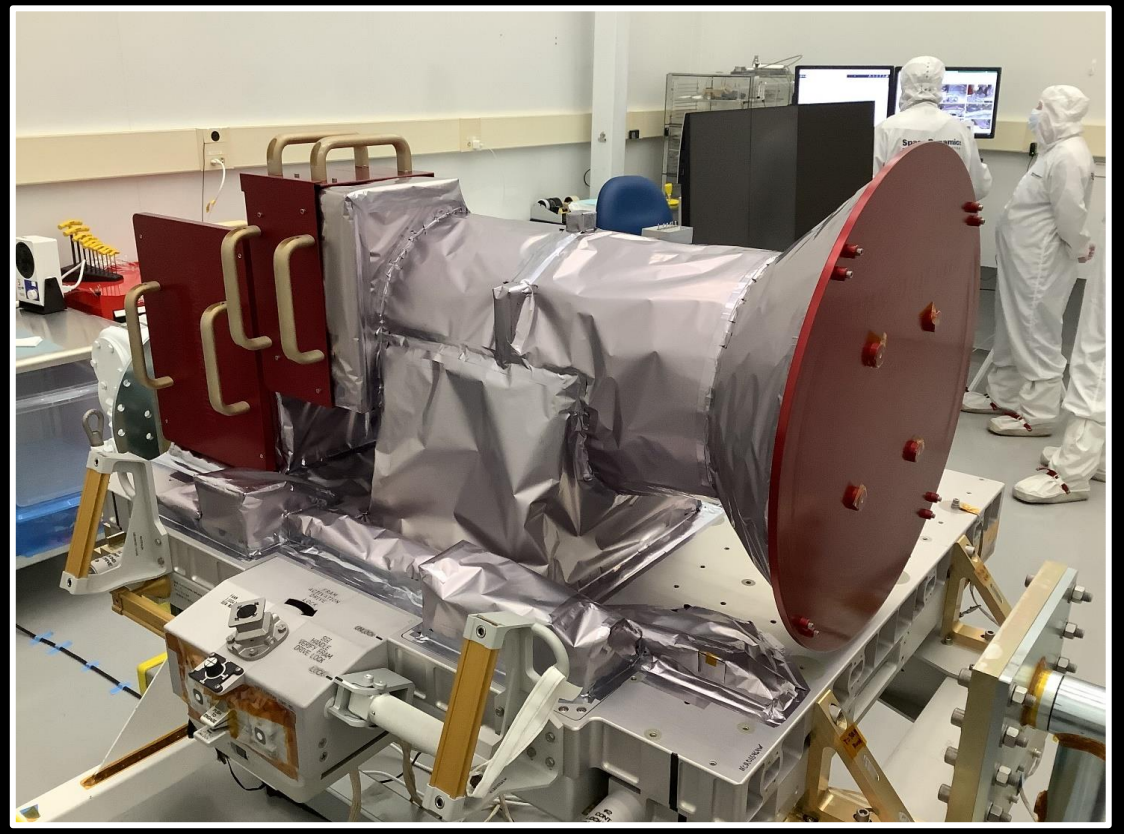
HELIOPHYSICS
BIG YEAR

HELIO MISSION LAUNCH TIMELINE

AWE	ESCAPADE	Carruthers Geocorona Observatory	IMAP	SunRISE	TRACERS	PUNCH	HERMES	EZIE
								
~November **2023**	~August **2024**	~February **2025**	~February **2025**	~March **2025**	~April **2025**	~April **2025**	~October **2025**	~March **2026**

Atmospheric Waves Experiment (AWE)

- Launching November 2023
- Will deploy the nadir-viewing Advanced Mesospheric Temperature Mapper (AMTM) on the exterior of the International Space Station in low Earth orbit.
- Will measure atmospheric gravity waves in the infrared to determine how these disturbances from terrestrial weather transports energy from the lower to the upper atmosphere.
- Will obtain global observations to understand how terrestrial weather affects space weather in a dynamic region of Earth's upper atmosphere.



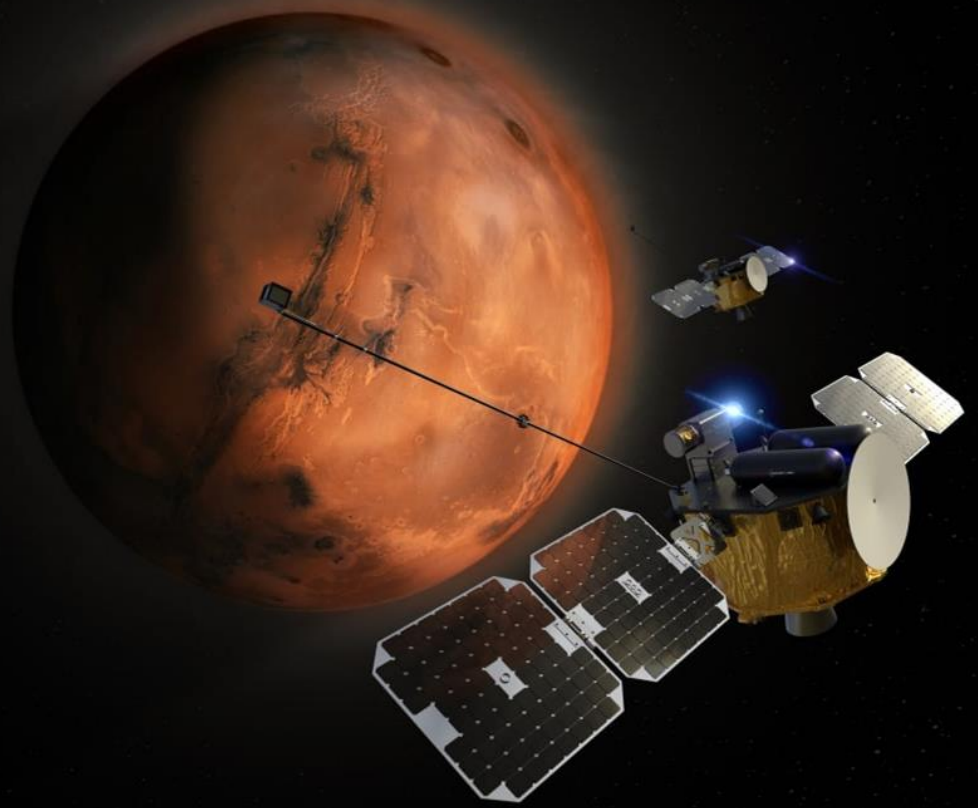
Credit: Utah State University and Space Dynamics Lab

https://blogs.nasa.gov/awe/

ESCAPADE

Escape and Plasma Acceleration and Dynamics Explorers

- Launching August 2024
- ESCAPADE is comprised of two small ESPA Grande-class spacecraft.
- Will arrive at Mars science orbit April 2026 for 11-month science mission.
- Will observe how energy and momentum are transported from the solar wind through Mars' magnetosphere.
- Will study what processes control the flow of energy and matter into and out of the atmosphere.



https://blogs.nasa.gov/escapade/

SPACE WEATHER AT MARS


SPACE WEATHER AT EARTH

https://solarsystem.nasa.gov/solar-system/sun/helio-big-year/

NASA.gov/sunearth

blogs.nasa.gov/sunspot

@NASASun

facebook.com/NASASunScience

QUESTIONS?

NASA Advisory Committee
Science Committee
Summer Meeting
Aug 2023

Public Comment Session

Committee Discussion