

National Aeronautics and
Space Administration



EXPLORE SCIENCE

MODIS/VIIRS Science Team Meeting

Sandra A. Cauffman
Deputy Director
Earth Science Division

November 19, 2020

Outline

Earth Science Overview

Appropriation/Budget Status

2017 Earth Science and Applications from Space Decadal Survey

Cross Benefits R&A and Applications

Open Science

Committee on Earth Observations (CEOS)

The background of the slide is a composite image of space. The top half features a dark blue and black nebula with bright, glowing spots. The bottom half is dominated by a large, vibrant orange and yellow nebula, with a transition to a greenish-blue area on the right side. The overall effect is a rich, multi-colored cosmic scene.

Earth Science Division Overview

Earth as a Complex Interrelated System





Sentinel-6 Michael Freilich ♦ November 21, 2020

Landsat 9

Designed and operated to repeatedly observe the global land surface at a moderate scale that shows both natural and human-induced change. *(With USGS)*

September 2021



Earth Science Division Diversity and Inclusion Task Force

Our Goal: Building a diverse, equitable, inclusive and accessible environment for marginalized communities within the Earth science community.

The Work Ahead

- We've established an ESD Diversity and Inclusion Task Force to identify the most effective and impactful actions that can be directly undertaken within and specifically benefit the Earth science community.
- Collect and analyze current data and metrics to level set our understanding of where we are as a community, and what specific actions we can take to grow.
- Champion Dual Anonymous Peer Review and other measures to address perceived bias in our panel review process.
- Further expand upon current footprint with STEM partnerships and increase participation with Historically Black Colleges and Universities and other Minority Serving Institutions.
- Highlight and amplify the accomplishments of our diverse NASA scientists and researchers – to encourage a more diverse generation of STEM professionals.

COVID-19 Update

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

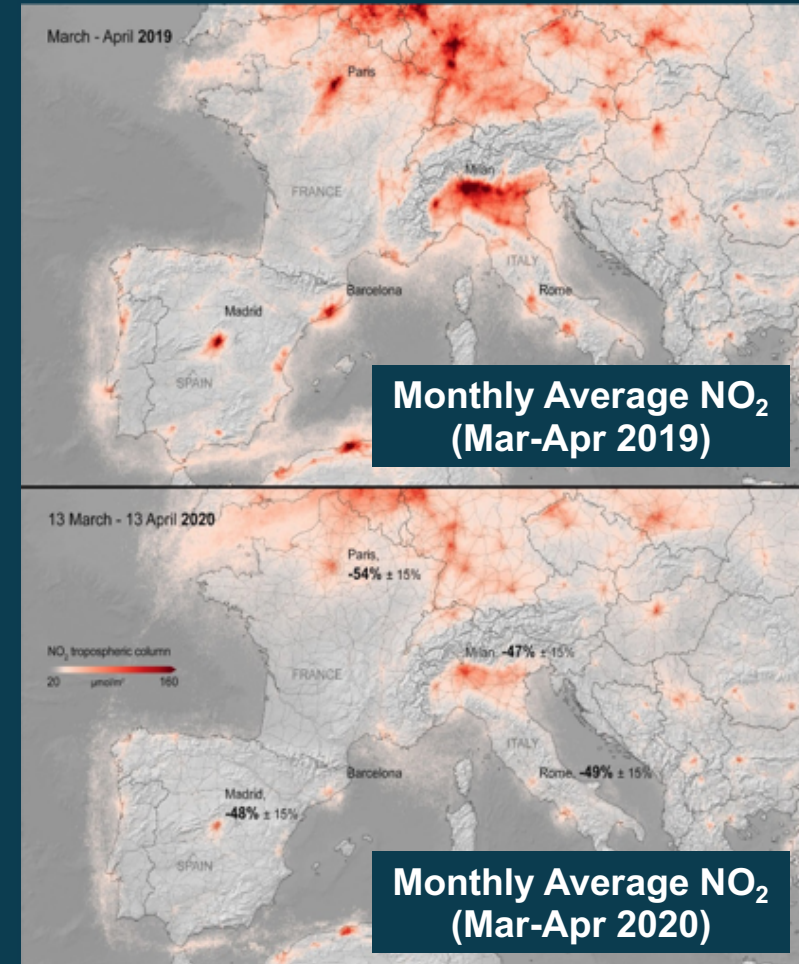
<https://eodashboard.org/>



COVID-19 Dashboard

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

- In April, JAXA, NASA, and ESA launched a collaboration to use satellite data for tracking and analyzing changes in the global environment and socio-economic activity as a result of the pandemic.
- The working group established for this purpose have developed an Earth Observing Dashboard that integrates multiple satellite data records with analytical tools to allow user-friendly tracking of changes in air and water quality, climate change, economic activity, and agriculture.
- Most visited indicators include: Greenhouse Gases, SAR Slowdown Proxy Maps, Nightlights, Finished Goods Production: Output Inventory Level, Air Quality Time Series, and Water Quality Maps: Total Suspended Matter.

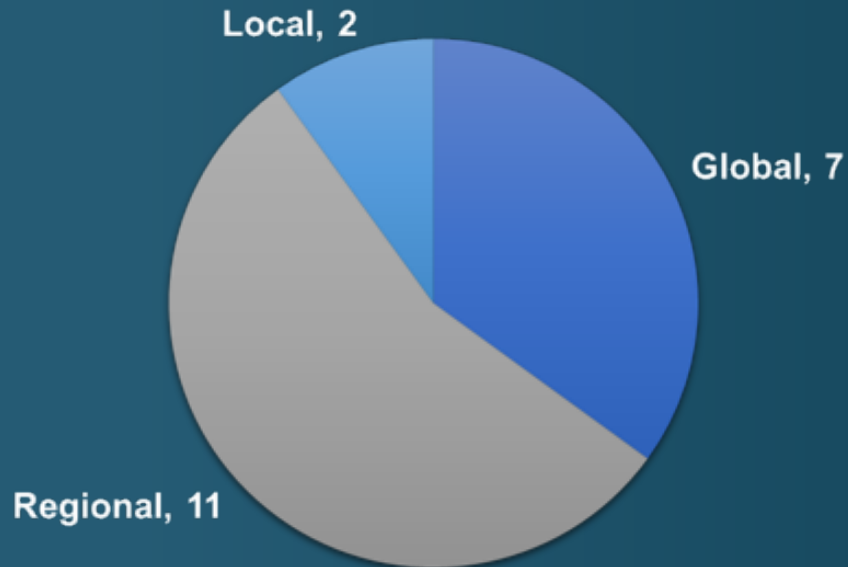


Research & Analysis Response to COVID-19: Rapid Response and Novel Earth Science (ROSES-19)

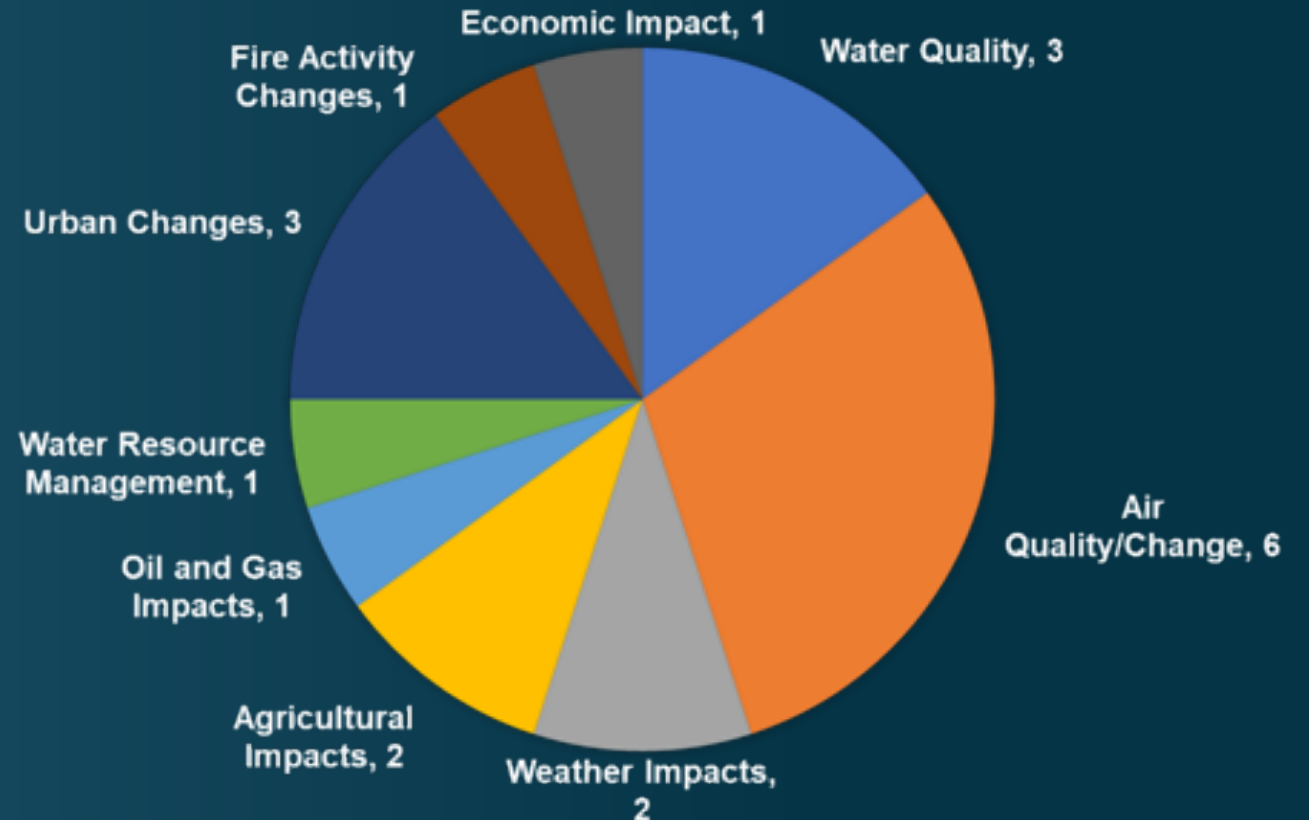
<https://science.nasa.gov/earth-science/rres-awards>

>130 inquiries
43 proposals submitted
20 selections to date

Geographic Extent of Research



Areas of Research of COVID-focused RRNES



NASA International Space Apps Challenge 2020

spaceappschallenge.org

5 space agencies (NASA, CSA, CNES, JAXA, ESA)

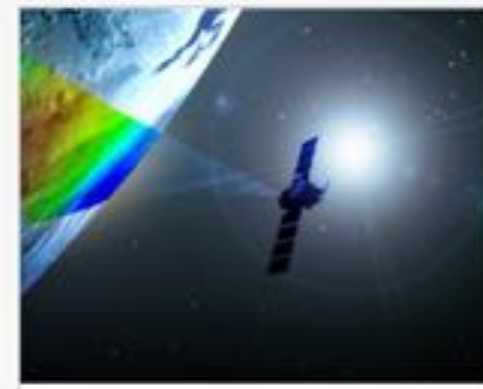
26,000+ registered participants

Nearly 150 countries/territories represented

2,300+ projects submitted



Confront



Connect



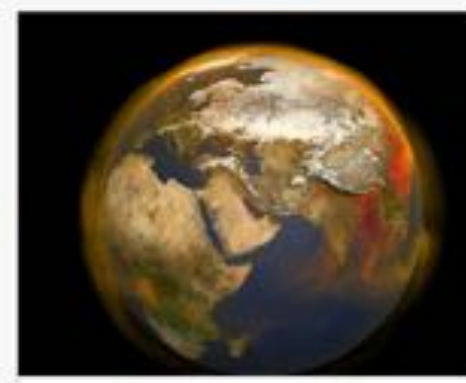
Invent Your Own Challenge



Observe



Inform



Sustain

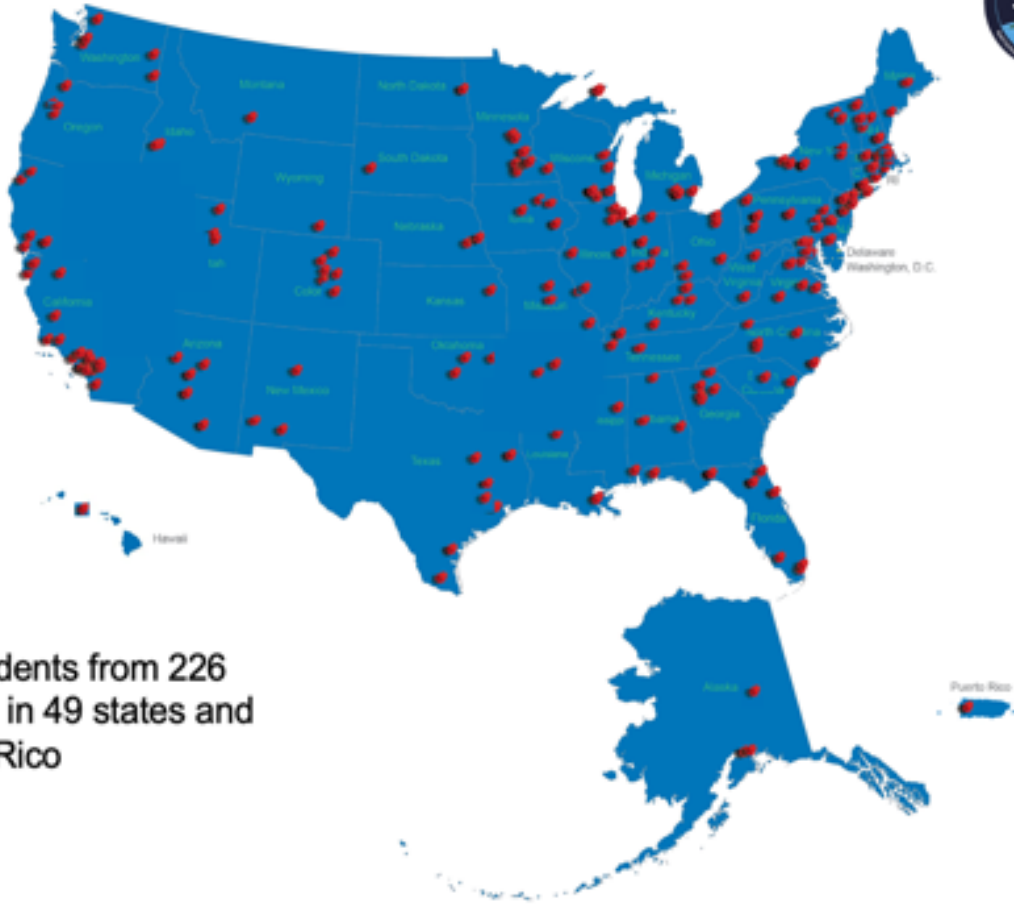


Create

SARP 2009-2020 Achievements

- 11 peer-reviewed publications from SARP data
- 93% retention in STEM fields
- Over 50 alumni now have PhDs in STEM fields
- Alumni now participating as scientists and engineers in NASA Airborne Science Program missions all over the world

NASA Student Airborne Research program 2009-2020



361 students from 226 schools in 49 states and Puerto Rico



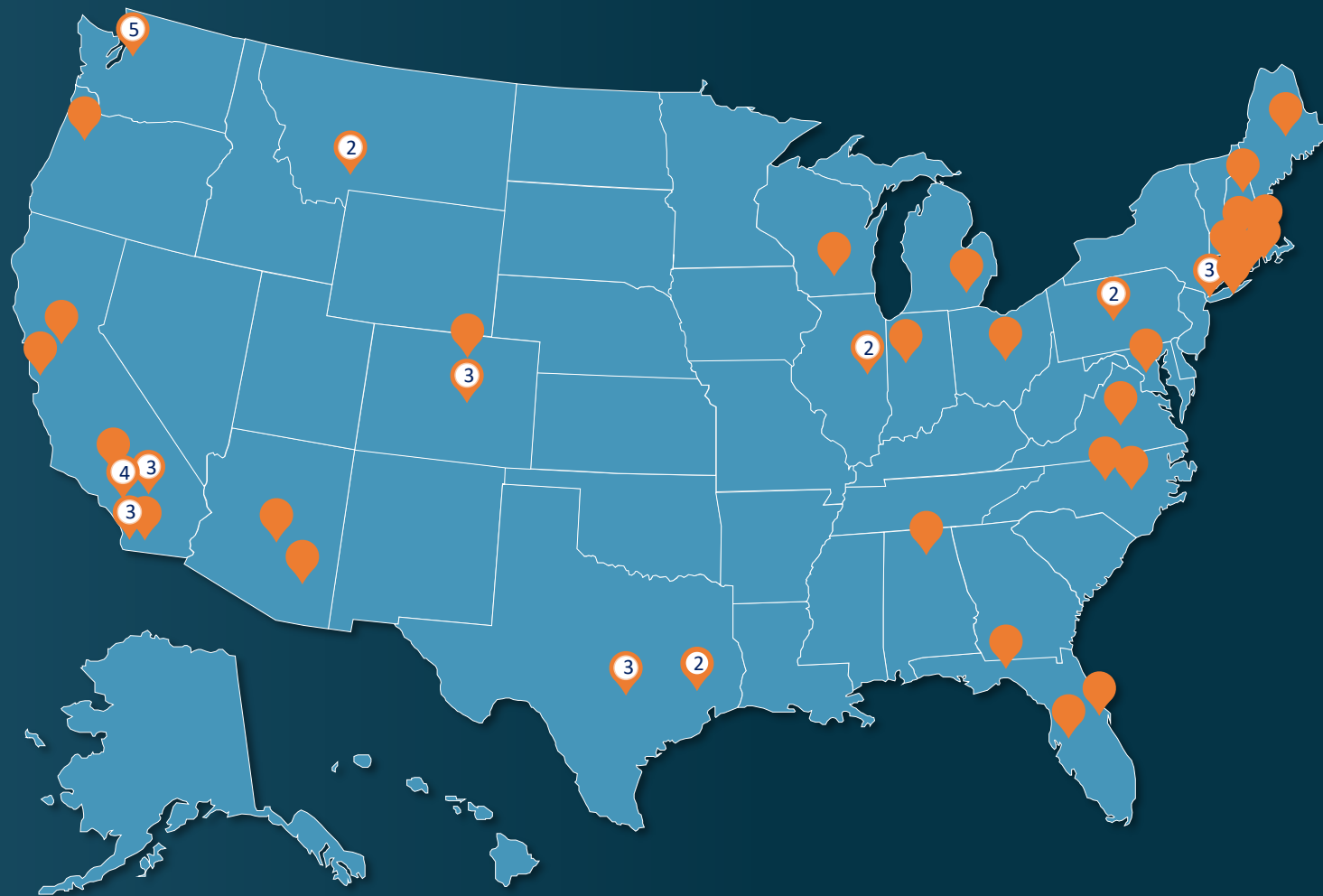
SARP at Home: Whole Air Sampling Group Project



SARP students, mentors, faculty and NASA scientists took air samples near their homes that were subsequently analyzed for nearly 100 different gases

Future Investigators in NASA Earth and Space Sciences and Technology (FINESST) Selections

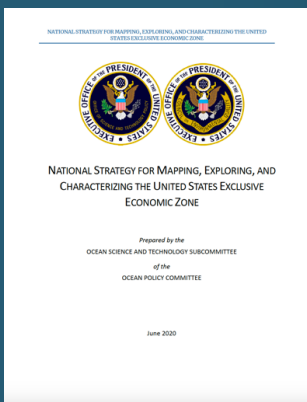
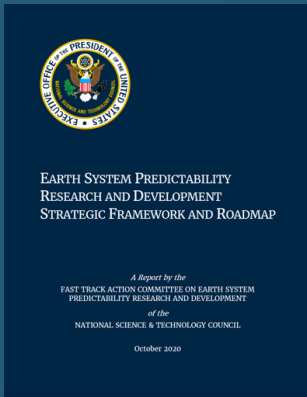
- **341** proposals reviewed in disciplinary-specific panels
- **62** selections in May 2020 – up to 45K per year for up to 3 years; periods of performance will begin around September 1, 2020
- FINESST grants are for student-designed research projects that contribute to SMD's science, technology, and exploration goals
- The purpose is to provide relevant research and/or technology development project training in disciplines needed to achieve the goals of NASA Science Mission Directorate
- Selection keywords: satellite, data, models, snow, quantify, global, remote, cloud



62 Selections from **40** Institutions

ESD Role in Interagency Activities - New

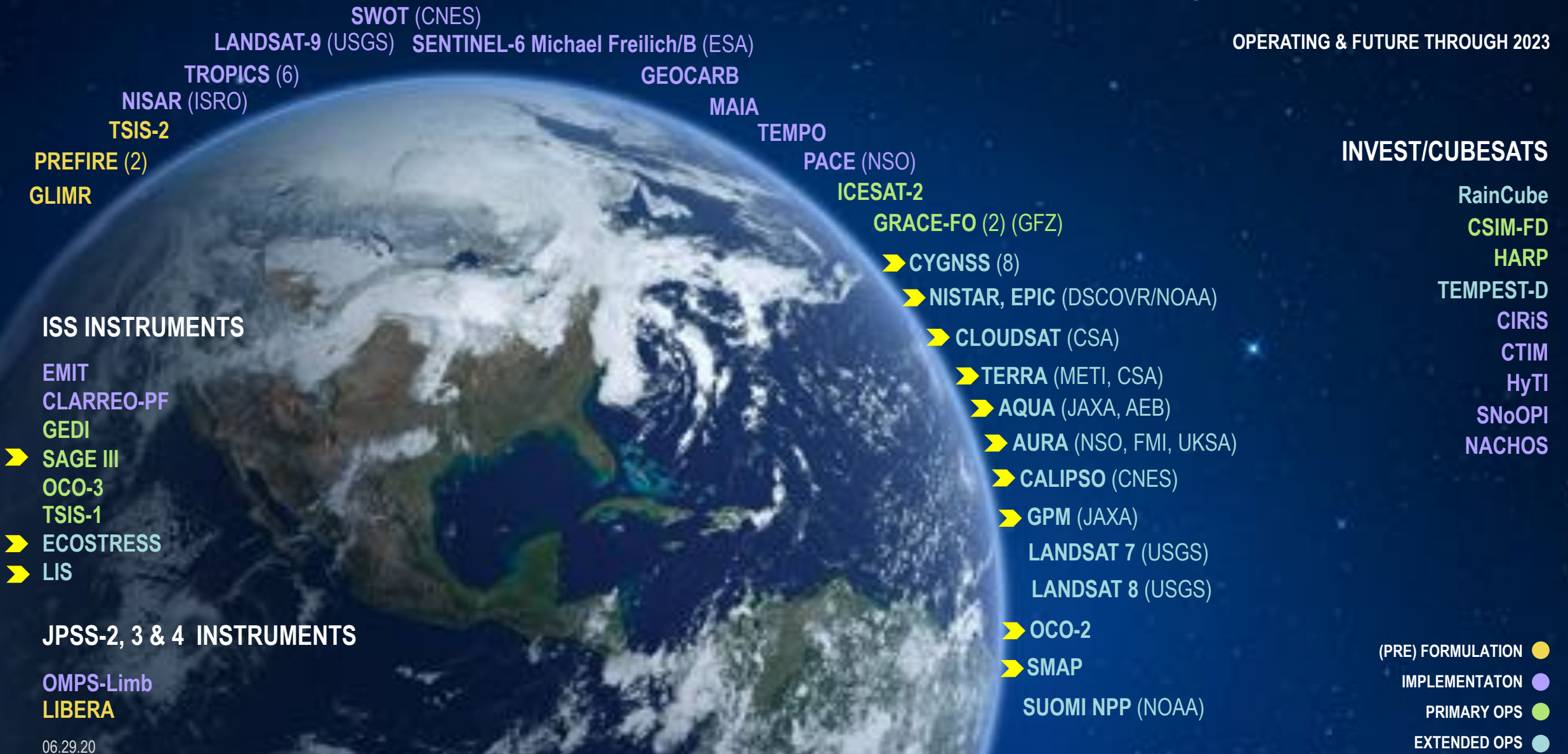
- NASA/ESD continues to be heavily involved in a variety of interagency activities. Some recent additions to the usual (USGCRP/SGCR, OST, IARPC, USGEO) include
 - *Fast Track Action Committee on Earth System Predictability* – NASA provided one of three co-chairs for overall committee, and members of writing teams developing plan; public-facing report released in October; multiple NASEM activities held. NASA released RFI for community input.
 - *National Ocean Mapping, Exploration, and Characterization Council* – established to help implement the new National Strategy for Mapping, Exploring, and Characterizing the United States Exclusive Economic Zone (report released in June). NASA has representatives on two subgroups (Ocean & Coastal Mapping, Ocean Exploration and Characterization)
 - *Interagency Council for Advancing Meteorological Services* – established in response to the 2017 Weather Research and Forecasting Innovation Act of 2017, including establishment of four committees (Observational Systems, Cyber, Facilities, and Infrastructure, Services, and Research and Innovation). NASA has members on all four and provides co-chairs for two (observations, research/innovation). Subcommittee structure is being developed and committee members are being named. ICAMS principals have met twice so far. An Interagency Meteorology Coordination Office (IMCO) will subsume the functions of the Office of the Federal Coordinator for Meteorology.



2020 Senior Review Results

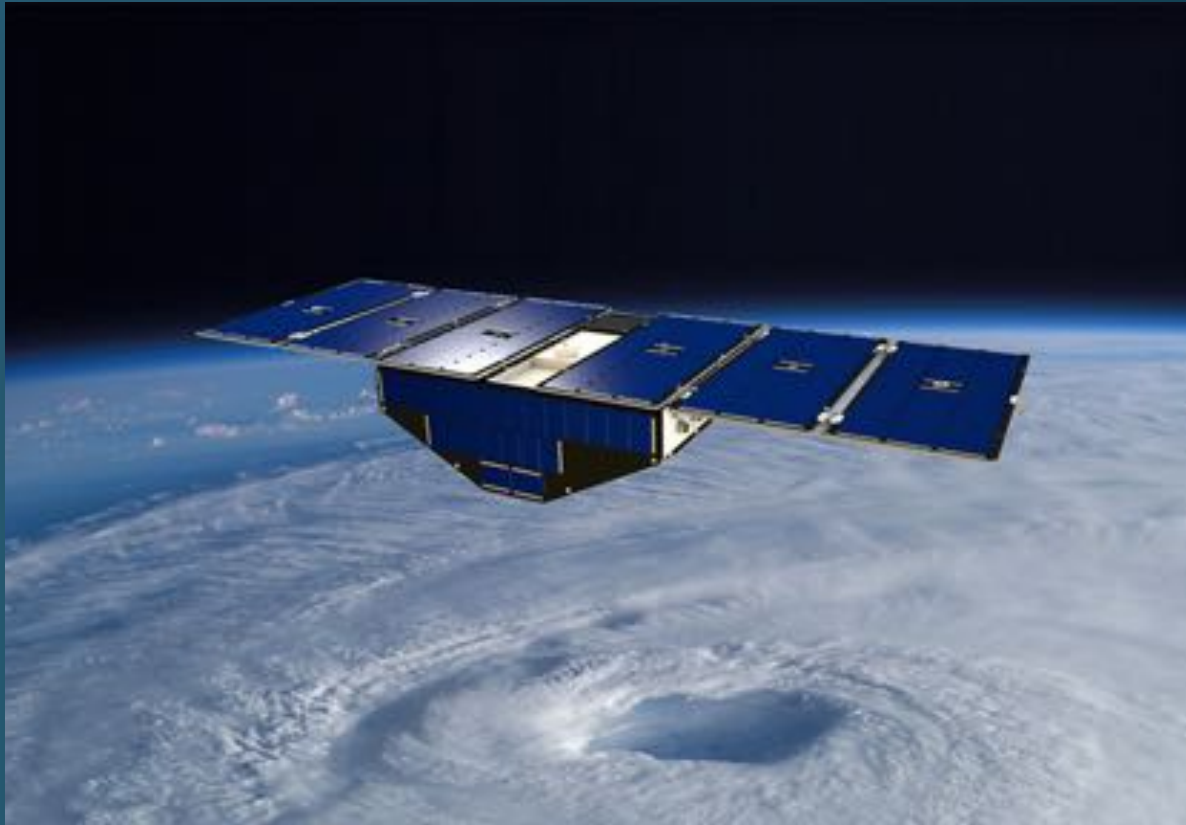
NASA EARTH FLEET

OPERATING & FUTURE THROUGH 2023

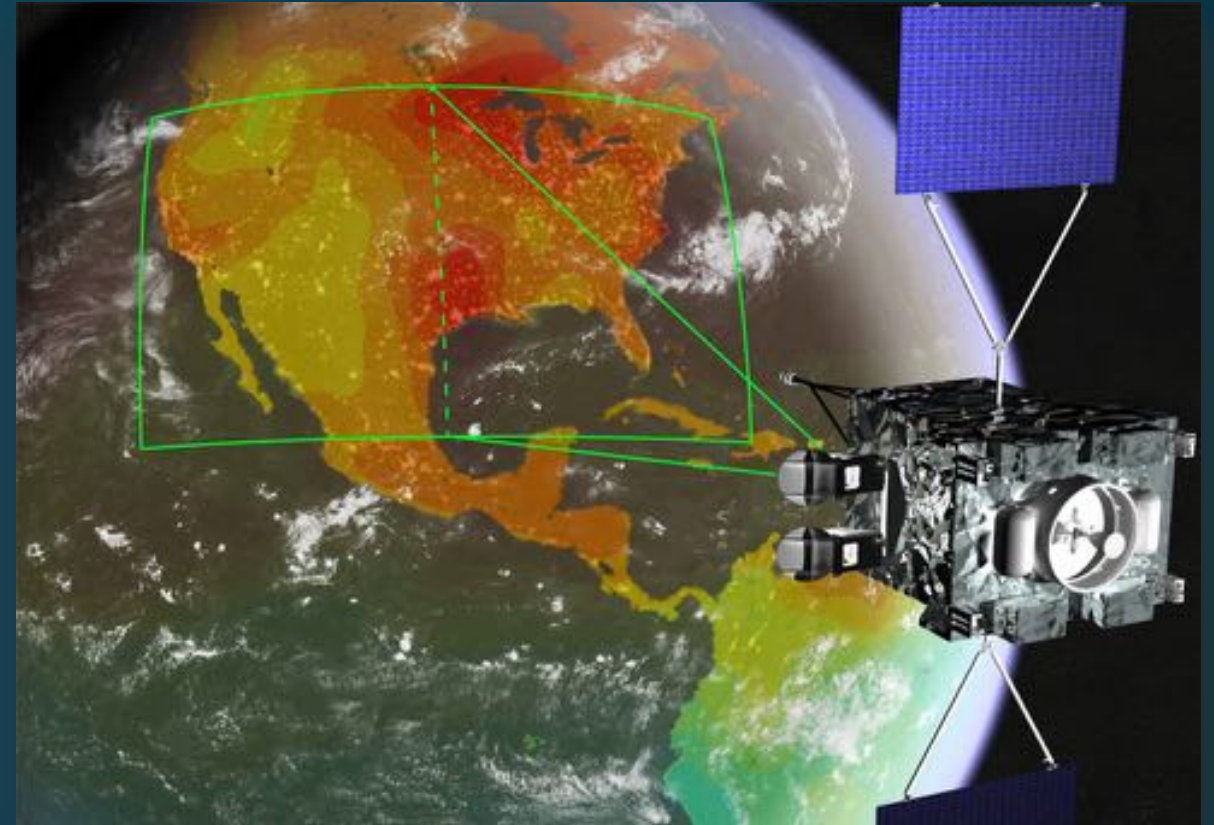


06.29.20

EVM-3 Announcement of Opportunity (AO) – Released 18 November 2021, proposals due 4 March 2021



EVM-1 (CYGNSS)



EVM-2 (GeoCarb)

Earth Venture & The National Academies

NASEM Study:

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

The NASEM mid-term study:

Include a focused review of the Earth Venture Suborbital (EV-S) program as specified in the 2017 Decadal Survey.

The National Academies of
SCIENCES • ENGINEERING • MEDICINE
—
Advising the Nation

The background of the slide is a cosmic scene featuring a blue nebula in the upper right and an orange nebula in the lower left, with a dark space filled with stars in between.

Budget Update

FY21 Science Budget Request Summary (\$M)



ESD FY21 Budget Outlook (\$M)

- PBR Request = **1,768.1**
- House = **2,021.8**
- Senate = **1,984.4**

	Actual FY 19	Request FY 20	Enacted FY 20	Request FY 21	Out-years			
					FY 22	FY 23	FY 24	FY 25
Science	6,886.6	6,393.7	7,138.9	6,306.5	6,553.5	6,575.7	6,705.2	6,766.9
Earth Science	1,931.0	1,779.8	1,971.8	1,768.1	1,878.2	1,846.1	1,834.5	1,984.6
Earth Science Research	454.1	447.9		447.3	471.9	494.1	528.5	530.3
Earth Systematic Missions	932.7	719.2		608.3	706.1	695.6	640.7	797.3
Earth System Science Pathfinder	223.8	275.4		338.9	301.2	251.6	241.8	234.4
Earth Science Data Systems	202.0	214.4		245.4	259.9	263.2	278.7	277.7
Earth Science Technology	63.4	69.6		74.2	82.8	84.6	86.4	86.4
Applied Sciences	55.1	53.3		53.9	56.3	57.0	58.5	58.5
Planetary Science	2,746.7	2,712.1	2,713.4	2,659.6	2,800.9	2,714.9	2,904.8	2,830.7
Planetary Science Research	276.6	266.2		305.4	288.6	285.1	295.2	286.7
Planetary Defense	150.0	150.0	160.0	150.0	147.2	97.6	98.0	98.0
Lunar Discovery and Exploration	188.0	300.0	300.0	451.5	517.3	491.3	458.3	458.3
Discovery	409.5	502.7		484.3	424.4	434.8	570.1	505.8
New Frontiers	93.0	190.4		179.0	314.3	332.8	326.9	285.0
Mars Exploration	712.7	546.5	570.0	528.5	588.4	671.2	798.7	855.3
Outer Planets and Ocean Worlds	793.6	608.4		414.4	370.7	239.4	192.3	171.7
Radioisotope Power	123.3	147.9	147.9	146.3	150.1	162.8	165.4	169.8
Astrophysics	1,191.1	844.8	1,306.2	831.0	891.2	1,000.9	959.7	975.5
Astrophysics Research	222.8	250.7		269.7	279.1	327.2	314.9	331.1
Cosmic Origins	222.8	185.3		124.0	123.2	120.0	122.4	122.4
Physics of the Cosmos	151.2	148.4		143.9	160.8	155.3	169.8	154.1
Exoplanet Exploration	367.9	46.4		47.2	50.4	47.6	51.6	52.2
Astrophysics Explorer	226.5	214.1		246.2	277.7	350.8	301.0	315.6
James Webb Space Telescope	305.1	352.6	423.0	414.7	175.4	172.0	172.0	172.0
Heliophysics	712.7	704.5	724.5	633.1	807.8	841.8	834.1	804.1
Heliophysics Research	248.9	237.0		230.5	218.7	225.2	224.0	224.5
Living with a Star	135.3	107.6		127.9	134.5	246.4	225.5	233.3
Solar Terrestrial Probes	180.5	177.9	183.2	126.3	262.2	202.6	195.6	115.5
Heliophysics Explorer Program	147.9	182.0	182.0	148.4	192.4	167.6	189.0	230.8

Earth Science FY21 PBR Budget Features

- Supports 22 on-orbit missions, including instruments operating on the ISS, and 14 missions in development
- SWOT, NISAR, Sentinel-6 Michael Freilich, Sentinel-6B, Landsat 9, TEMPO, GeoCarb, and MAIA remain on schedule for launch in budget window from FY21-FY25
- Maintains regular cadence of Venture Class solicitations (Suborbital, Mission, Instrument); supports the first Earth Venture Continuity mission selection – EVM-3 AO released Nov. 18, 2020
- Continue Decadal Studies with the start of the first DO in pre-Phase A in early 2021
- Sustainable Land Imaging supports the development of the next generation of Landsat observing systems as well as a focused program of land imaging technology studies – Initiated Landsat Next pre-Phase A.
- Robust research and applied science programs, SmallSat/CubeSat investments, and commercial data buy activities
- Like FY19-20 Presidential Budget Requests, provides no funding for PACE and CLARREO-PF
- In the process of factoring all COVID impacts in above activities



NASA's Geosynchronous Littoral Imaging and Monitoring Radiometer (GLIMR) instrument will collect high-resolution observations of coastal ecosystems in such areas as the northern Gulf of Mexico, shown in this image with phytoplankton blooms stretching from the Texas and Louisiana coast (left) across the Mississippi River delta (center) toward Florida (far right).

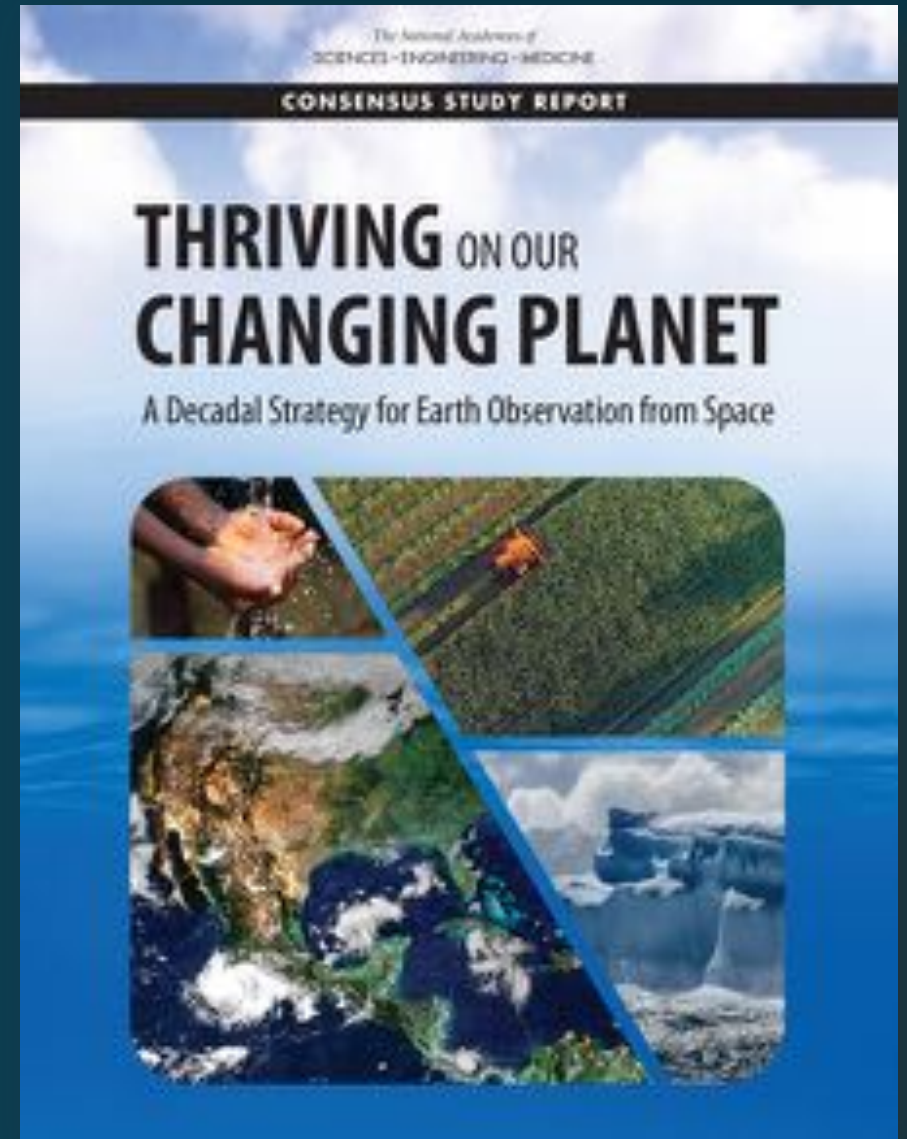
The background of the slide is a composite image of space. The top half features a dark blue and black field with a prominent, bright blue nebula on the right side. The bottom half is dominated by a large, glowing orange and yellow nebula on the left, which transitions into a greenish-blue field on the right. Numerous stars of various colors are scattered throughout the scene.

Decadal Survey Overview

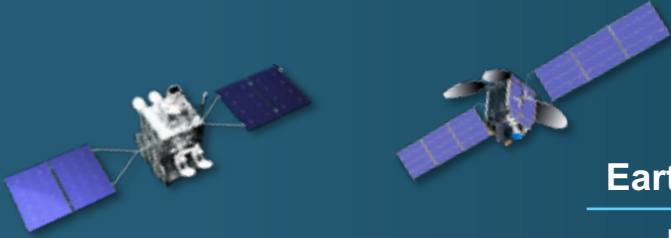
2017 Decadal Survey Snapshot

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

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



2017 Decadal Survey Progress Highlights



Earth System Explorers

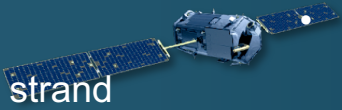
- DS recommended a new competed Explorer flight line with \$350M cost constraint

Implement 3 of 7 Targeted Observables

- Framework for program established
- Implementation on hold pending budget developments

Earth Venture-Continuity

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

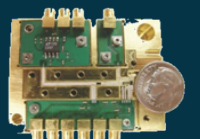


Decadal Incubation

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

Designated Observables

- DS identified 5 Designated Observables (DOs) for mandatory acquisition
- In 2018 ESD initiated 4 multi-center DO studies, continued in 2019:
 - Combined: Aerosols-Clouds, Convection & Precipitation
 - Mass Change
 - Surface Biology & Geology
 - Surface Deformation & Change
- First DO Architecture Down Select by the end of Calendar Year 2020 to enter pre-Phase A
- Fully funds a DO project to be initiated in FY21, and initiates two more in FY23, and FY26



Progress Thus Far

- Development of mission options and analyses by strong, multi-Center teams
- Industry engagement, RFIs & funded studies
- Community engagement
- Exploring range of international partnerships
- Preliminary cost analysis for U.S. elements
- Cross-cutting Data & Open Science strategy

Alignment Principles to Guide Designated Observable Studies

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

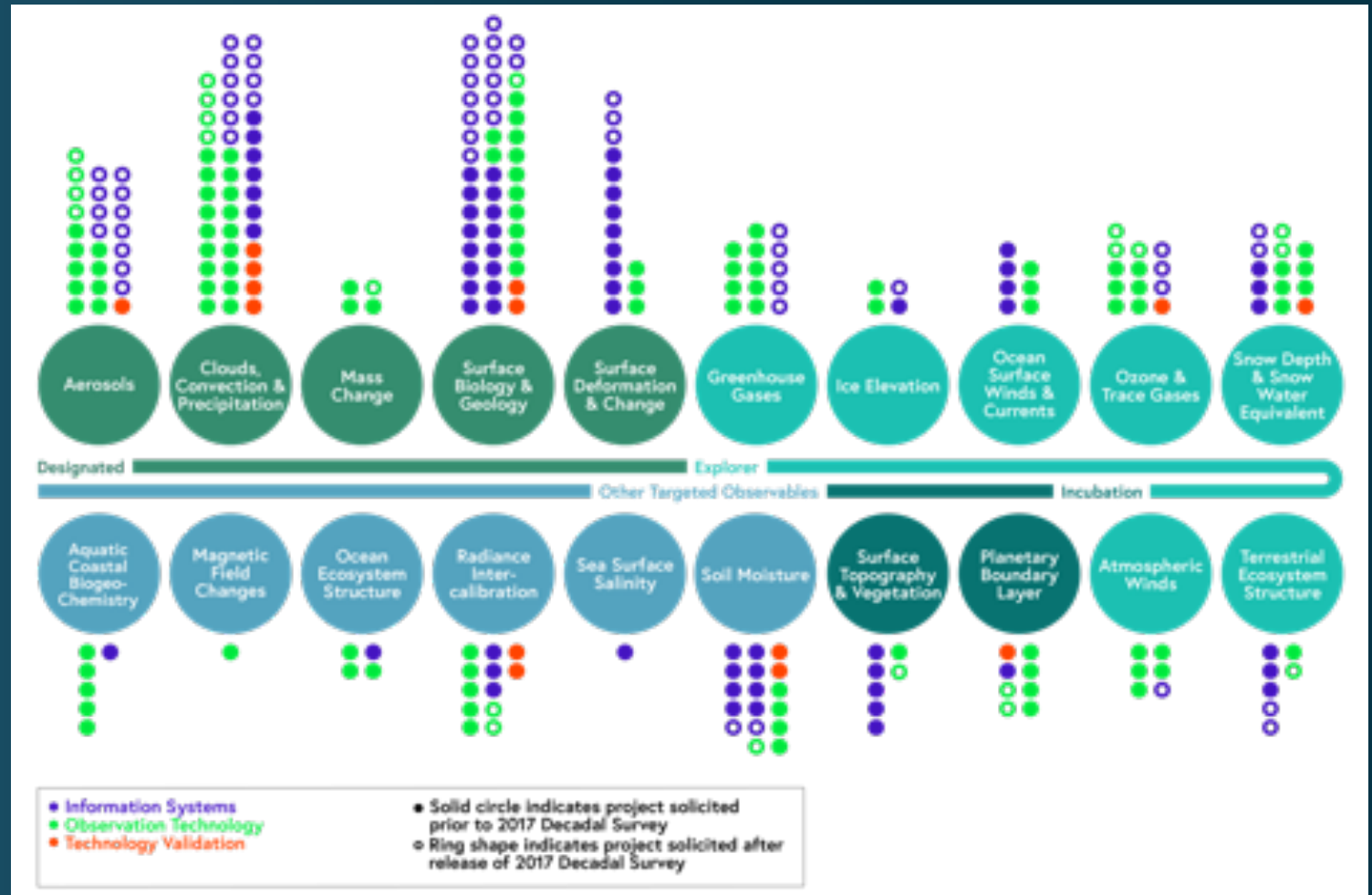
Earth Science Explorer: Strategy

Implementation on hold pending budget developments

- ESD decided to limit Atmospheric Winds to Explorers – removed from Incubation list
- ESE will use a two-step AO process, similar to mission solicitations in other SMD Divisions
 - \$350M cost-capped (including launch services) observing systems/missions to be solicited
 - 9 -14 month Phase A prior to down-select
 - First solicitation will likely allow proposals for any observable from the DS Explorers list
 - Subsequent ESE solicitations will likely restrict primary observable foci based on previous selections
 - ESD will encourage solicitations that address more than one ESE Observable and that support other aspects of the DS-recommended ESD portfolio
- The first ESE solicitation depends on future budget developments
- New Earth System Explorers Program Office to be established

Technology Investments for Targeted Observables

ESTO's portfolio includes projects addressing all 20 observables highlighted in the most recent Earth Science Decadal Survey.



Investments made since 2013

PBL Study Update

• Community Engagement

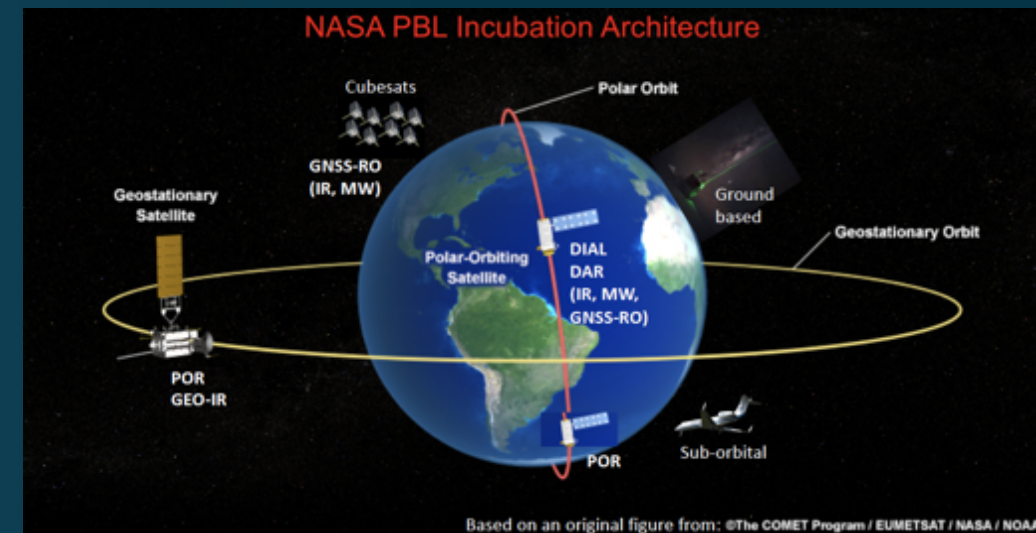
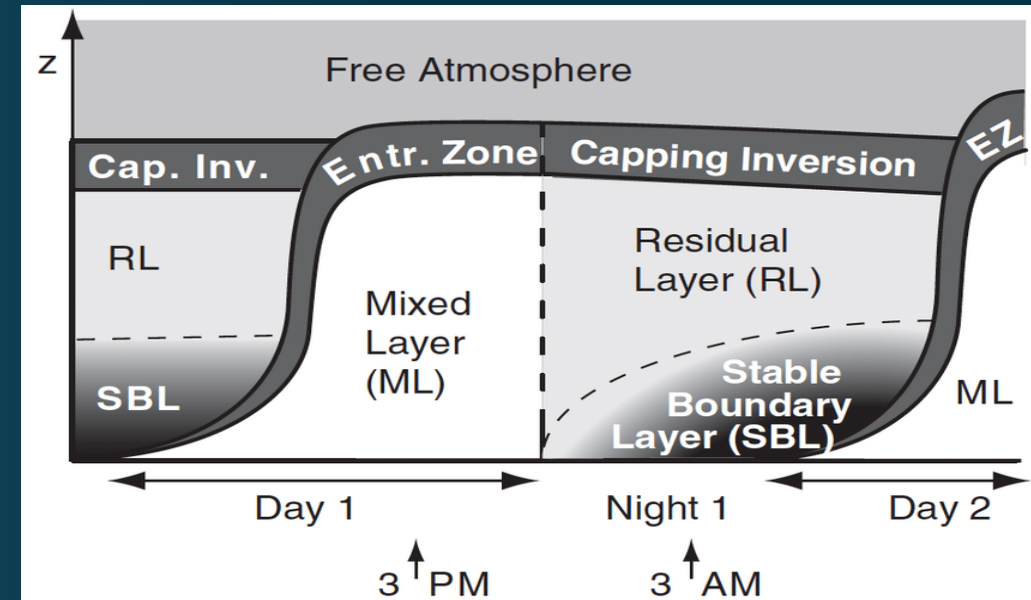
- **Community Workshop, May 19, 20, 25, 26, 2020**; average 200 attendees each session
 - High-latitude PBL & PBL and Deep Convection,
 - Land and Surface Interaction & Ocean and Sea Interaction,
 - Applications & Weather, Climate Models, and Data Assim.
 - Passive & Active PBL sensing, & In-situ and Suborbital
- **October 13, 2020: PBL Technology Survey released**
 - ~50 responses so far
 - Submit entries ASAP to pbl-study-input@lists.nasa.gov

• Schedule

- **September 11, 2020**: Draft Study Team white paper delivered to NASA HQ (50 pages)
- **November 2020**: White paper revision incorporating HQ feedback due
- **NLT January 2021**: Final white paper due
- **Ongoing**: PBL augmentation activities
- **PBL Activity Proposal Solicitation(s)**: 3-9 months after white paper released to the public

• Key Preliminary Findings

- Architecture of multiple platforms and sensors on orbital and suborbital assets would best address PBL needs



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

STV Study Update

• Community Engagement

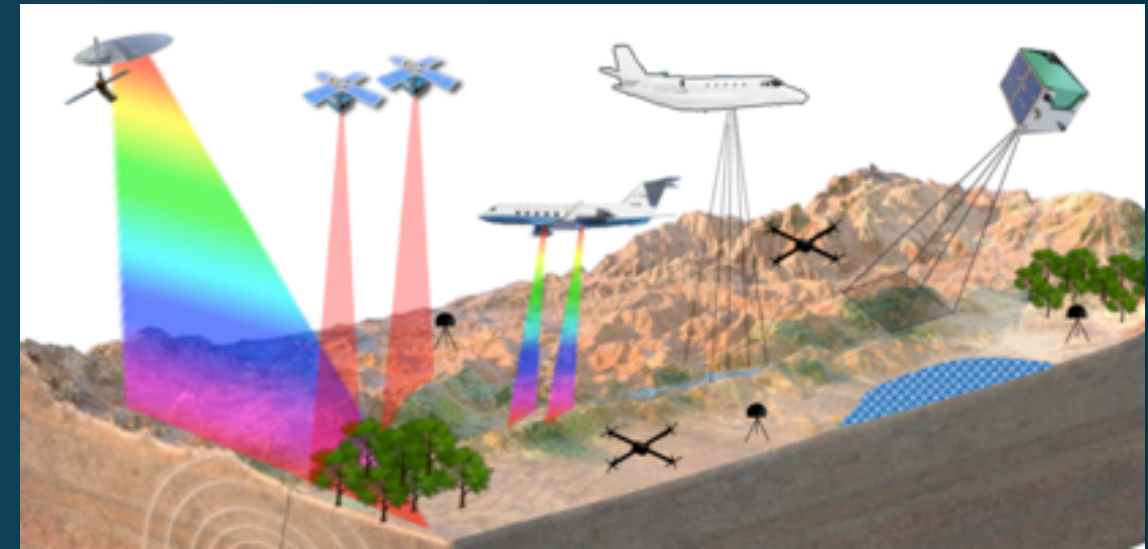
- Kick-off Plenary, July 9, 2020, 300 attendees
- July: Science & Application Breakouts, averaging 51 attendees
 - Solid Earth, Vegetation, Cryosphere, Hydrology, Bathymetry
- August: Objectives and Product Needs Questionnaire
 - 149 responses
- September: Technology Breakouts, averaging 49 attendees
 - Lidar, Radar, Stereo Photogrammetry, Information Systems
- September: Current and Emerging Technology Quad Charts
 - 60 responses

• White Paper Schedule

- October 29: Draft delivered to HASA HQ
- Late November: Revision incorporating HQ feedback
- December 3: AGU STV Townhall: Release of draft to community and solicit comments
- Dec - Jan: Revision based on comments
- End of February: Delivery of final white paper

• Key Preliminary Findings

- Need global baseline mapping and targeting for change
- Architecture of multiple platforms and sensors on orbital and suborbital assets would best address STV needs



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

The background of the slide features a cosmic scene with a dark blue and teal nebula in the upper right and a bright orange and yellow nebula in the lower left. Numerous stars of varying brightness are scattered across the field.

Cross-Benefits of Research and Applications

ESD & Cross-Benefit

[Programs] with both science and applications elements need to explicitly identify the connection, and define opportunities to amplify the cross-benefit ... *Decadal Survey, p. 61*

- DO Discussion topic: Accelerating Science & Applications Return
 - Data: How can the plan and schedule for precursor data, data product development, and calibration/validation support acceleration of research and applications?
 - Engagement: How can we inclusively broaden engagement and support of communities to stimulate additional and timely research and applications? for diverse feedback on data quality and usefulness and innovative uses?
 - Practices: What fundamental methodological advances might be shared (e.g., analysis capabilities, uncertainty quantification, modeling, assimilation techniques)

SMD ROSES Gaps RFI

- RFI to identify gaps in opportunities for interdisciplinary / interdivisional research issued late last year. We have received 97 responses from the community.
 - Some research projects are specific short-term projects or are second or third priority for divisions. Others fall between discipline stovepipes.
 - Technology development across multiple disciplines could be better coordinated.
 - Data science techniques and algorithms could be better shared and coordinated across the directorate.
 - Community desire for NASA to make larger investments in ground-based items (telescopes, sensors/instruments, lab).
 - Community wants NASA to review and build more holistic archives with appropriate policies for initiating, maintaining, and sunseting archives.

More information: https://science.nasa.gov/science-red/s3fs-public/atoms/files/Sheth_RFI%20Gaps_APAC_Oct2020.pdf

The background of the slide is a composite image of space. The top half features a dark blue and black nebula with bright, glowing spots. The bottom half is dominated by a vibrant orange and yellow nebula, also filled with numerous bright stars. A dark blue horizontal band runs across the center, containing the text.

Open Science

Open Science for Decadal Observables

Co-develop an Open Science Ecosystem to dramatically increase the speed of scientific discovery for DOs.

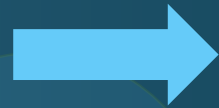
- Open access, availability and discoverability of data – shorten the time it takes for a new user (research and applied) to find and learn how to use data
- Open access to and advancement of modeling and simulation code – increase the community of hands-on contributions to improving models, assimilation, and prediction tools
- Share knowledge and use current informatics and data science tools, in the same ecosystem as the data – explore data in new ways
- Incentivize and energize innovation through prizes and challenges

ESD is leading the development of an open science ecosystem for SMD's Strategy for Data Management and Computing for Groundbreaking Science

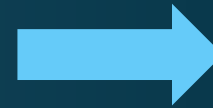


ESDS Manages the Single Largest Repository of Free & Open Earth Science Data

Make data available to as many people as possible.



Our users' expectations and abilities are changing.



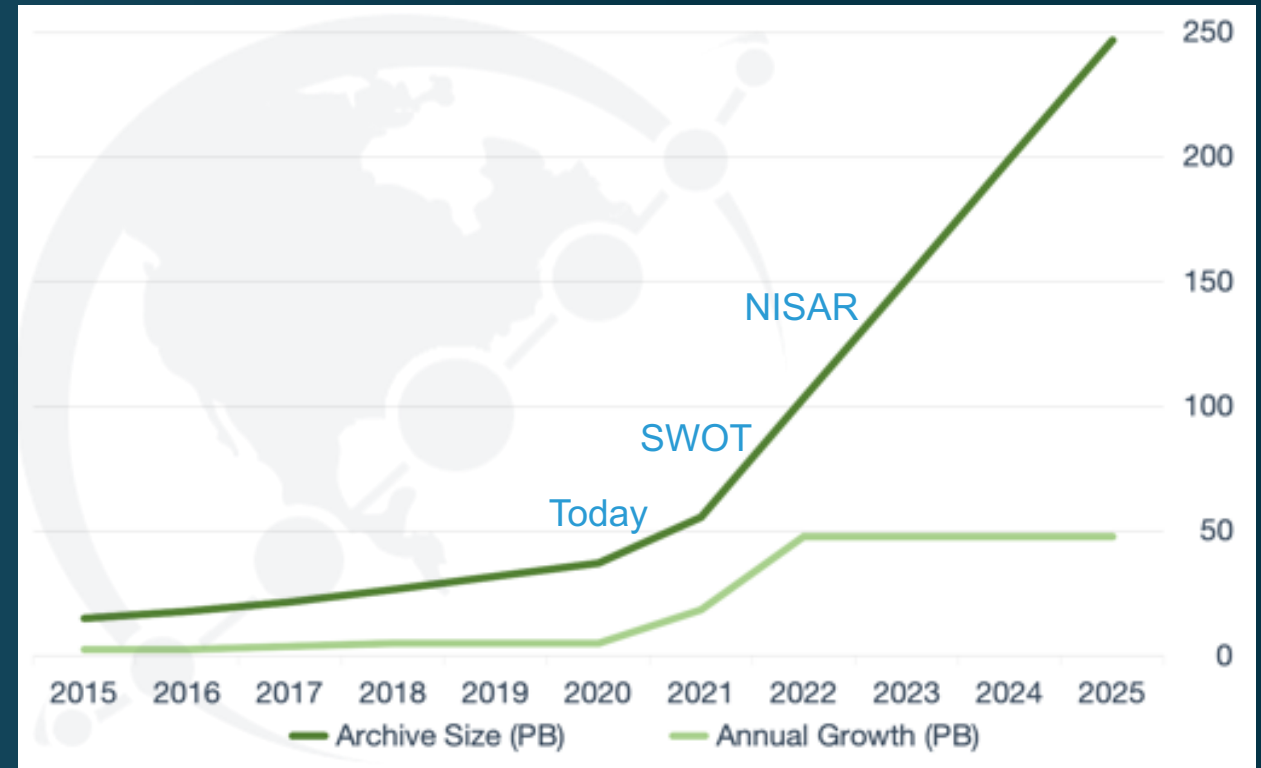
Data volumes for future missions will surpass in-house capacity/capability.

Cloud Evolution: Our future

- Scalable growth
- Operational and analytical efficiency
- Open science enables collaboration

Commercial cloud solutions

- Agility and speed
- Constant market-driven innovation by vendors (e.g., Amazon, Google)
- Represent quickest path to enabling change



The background of the slide is a composite image of space. The top half features a dark blue and black nebula with bright, glowing spots. The bottom half features a bright orange and yellow nebula with a dense field of stars. A dark blue horizontal band runs across the middle, containing the text.

Committee on Earth Observations (CEOS)

NASA Chairing CEOS in 2021

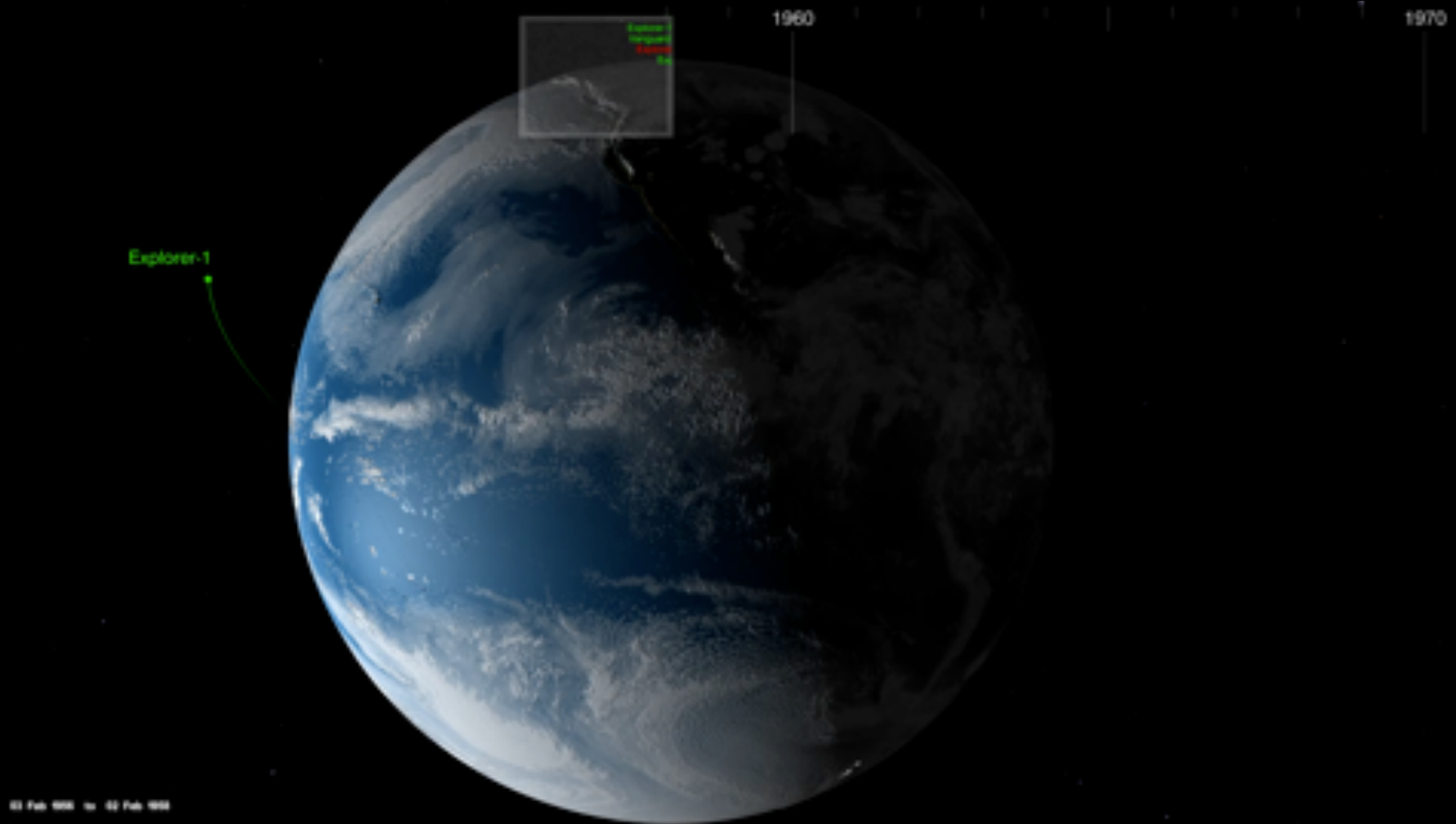
- Mission: CEOS ensures international coordination of civil space-based Earth observation programs and promotes exchange of data to optimize societal benefit and inform decision making for securing a prosperous and sustainable future for humankind.
- The Committee on Earth Observation Satellites (CEOS) is a consortium of 61 agencies operating 172 satellites worldwide working together to ensure international coordination of civil, space-based, Earth observation programs for the benefit of all.
- Now in its **third decade**, CEOS continues to demonstrate that it is a dynamic international forum, uniquely capable of coordinating space-based Earth observation (EO) activities of major impact, scope, and scale.
- CEOS remains a well-led organization, whose contributions and coordination are both **vital and highly relevant** to the remote sensing community and to science worldwide.



Proposed 2021 Chair Theme

- NASA invites the CEOS community to dedicate the 2021 CEOS Chair term as a benchmark year to elevate and more widely communicate how CEOS is actively realizing its vision through the theme:
 - *“Space-based Earth Observation Data for Open Science and Decision Support”*
- Our intent is to not add to the significant number of commitments that CEOS already has. Instead, the concept is to broadly disseminate the relevance of CEOS remote sensing activities and contributions in support of Open Science and decision making.
- Advancing Open Science will consider three topical areas: **accessibility, transparency and reproducibility**. Accessibility promotes the concept of free and open data, tools and algorithms that are easily found and used. Transparency promotes the concept of analyses and workflows that are clearly described and documents. Reproducibility promotes the concept that products can be reproduced now and into the future and that users have the required training and capacity building to understand that process.

Questions?



NASA Earth Observing Satellites Since 1958