National Aeronautics and Space Administration

ANNUAL REPORT 2021

LANDSAT 9

Continuing 50 years of eyes on our changing planet

Goddard Space Flight Center

www.nasa.gov

THE GODDARD PROJECT LIFE CYCLE

This icon indicates expanded multimedia content. An interactive version of this report is also posted at issuu.com/nasagsfc .

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World-Class Organization

60 YEARS AND COUNTING

10,000+ PEOPLE

Expert in the study of our world, the solar system and beyond, NASA's Goddard Space Flight Center has been working since 1959 to increase scientific understanding, answer humanity's big questions, and benefit the society and communities we serve. The center's work in science, engineering, technology and communications strengthens our ability to envision the origins of life, preserve our way of living and chart our place in the universe. We identify requirements and innovations; design, build and launch spacecraft; and manage and support entire space missions. Our foundational communications infrastructure enables NASA and others to retrieve knowledge from space, share it with diverse stakeholders and apply it to society in countless ways.

Goddard manages six sites: its main campus in Greenbelt, Maryland; Wallops Flight Facility in Wallops Island, Virginia; the Goddard Institute for Space Studies in New York; the Katherine Johnson Independent Verification & Validation Facility in Fairmont, West Virginia; the White Sands Complex in Las Cruces, New Mexico; and Columbia Scientific Balloon Facility in Palestine, Texas.

A MESSAGE FROM THE DIRECTOR

For more than six decades, NASA's Goddard Space Flight Center in Greenbelt, Maryland, has redefined humanity's understanding of the universe. From humble beginnings as the agency's first spaceflight center, Goddard now oversees six sites across the United States with more than 10,000 employees. Our science portfolio has grown to become among the most reputable in the world, encompassing core areas of astrophysics, Earth science, Heliophysics, and planetary science.

This year, similar to last, our mission faced a challenge in addition to those posed by the business of space exploration: the global COVID-19 pandemic. Knowing that the broader forces of the universe aren't deterred by the delays brought about by a virus, Goddard's personnel – adhering to the strictest safety guidelines – pushed forward diligently with project timelines and gave us one of our most successful years to date.

We augmented our role as an agency leader in space communications by launching the Laser Communications Relay Demonstration, which will showcase the agency's first two-way laser relay communications system by sending and receiving data over invisible infrared lasers. The Lucy mission sent into space is on its way to the Trojan asteroids near Jupiter, becoming the first such mission to explore the primordial bodies. After much anticipation, we launched the James Webb Space Telescope in December 2021. Once commissioning is complete and the long-awaited science operations begin, it will become the most powerful space telescope humanity has known.

Continuing a long-standing partnership between NASA and the U.S. Geological Survey, we launched Landsat 9 – the latest installment in the nearly 50-year Landsat program spearheaded by both agencies. In November 2021, we hosted Vice President Kamala Harris during a visit to our campus in Greenbelt to spotlight Landsat 9, present the first images from the spacecraft, and demonstrate how Goddard's broader Earth science portfolio is a leading tool in fulfilling the administration's goal to combat the global climate crisis.

The pages that follow provide a snapshot of the work being undertaken at all our six sites on behalf of the American people. They highlight not only our projects and missions, but above all, our diverse group of employees who execute the difficult work of spaceflight and push forward with the endless possibilities ahead.

As our successes this past year have shown, with challenges both expected and unexpected, the spirit of exploration and accompanying determination to make the seemingly impossible happen can lead to some of the greatest endeavors in human history.

On behalf of our center and its people, thank you for sharing in our journey in exploring the limits of the universe.

Dennis J. Andrucyk
Center Director

A GLOBAL LEADER IN EARTH SCIENCE

ADDRESSING THE GLOBAL CLIMATE CRISIS

The year 2021 brought a renewed focus on Earth's climate and how it is changing. With the launch of Landsat 9, new data from 2020 missions, and four new missions preparing for launch in 2022, NASA's Goddard Space Flight Center led the way in climate research and project development.

September 2021 saw the successful launch of Landsat 9, the latest mission in the 50-year Landsat partnership between NASA and the U.S. Geological Survey (USGS).

The first Landsat satellite launched in 1972. Since then, NASA has always kept a Landsat in orbit to collect images of the physical material covering our planet's surface and changes to land usage. Those images allow researchers to monitor phenomena including agricultural productivity, forest extent and health, water quality, coral reef habitat health, and glacier dynamics.

"The Landsat mission is like no other," said Karen St. Germain, director of the Earth Science Division at NASA Headquarters in Washington. "For nearly 50 years, Landsat satellites have observed our home planet, providing an unparalleled record of how its surface has changed over timescales, from days to decades. Through this partnership with USGS, we've been able to provide continuous and timely data for users, ranging from farmers to resource managers and scientists. These data can help us understand, predict, and plan for the future in a changing climate."

Landsat 9 joins Landsat 8 in orbit. Working in tandem, the two satellites will collect images spanning the entire planet every eight days.

"Landsat 9 will be our new eyes in the sky when it comes to observing our changing planet," said Thomas Zurbuchen, associate administrator for science at NASA. "Working in tandem with the other Landsat satellites, as well as our European Space Agency (ESA) partners that operate the Sentintel-2 satellites, we are getting a more comprehensive look at Earth than ever before. We'll have observations of any given place on our planet every two days. This is incredibly important for tracking things like crop growth and helping decision makers monitor the overall health of Earth and its natural resources."

The instruments aboard Landsat 9 – the Operational Land Imager 2 (OLI-2) and the Thermal Infrared Sensor 2 (TIRS-2) – measure 11 wavelengths of light reflected or radiated off Earth's surface, in the visible spectrum as well as other wavelengths beyond what our eyes can detect. As the satellite orbits, these instruments will capture scenes across a swath of 115 miles. Each pixel in these images represents an area about 98 feet across, about the size of a baseball infield. That high resolution will enable resource managers to identify most crop fields in the United States.

The USGS Earth Resources Observation and Science (EROS) Center in Sioux Falls, South Dakota, processes and stores data from the instruments, continuously adding that information to the five decades of data from all of the Landsat satellites.

All Landsat images and the embedded data are freely available to the public, a policy that has resulted in more than 100 million downloads since its inception in 2008.

NASA manages the Landsat 9 mission. Teams from Goddard also built and tested the TIRS-2 instrument. NASA's Launch Services Program, based at NASA's Kennedy Space Center in Florida, managed the launch of the mission. EROS will operate the mission and manage the ground system, including maintaining the Landsat archive. Ball Aerospace in Boulder, Colorado, built and tested the OLI-2 instrument. United Launch Alliance in Centennial, Colorado was the rocket provider for Landsat 9's launch. Northrop Grumman in Gilbert, Arizona, built the Landsat 9 spacecraft, integrated it with instruments, and tested it.

Climate Change Research

The past year was full of climate science advances from Goddard scientists. The launch of the Sentinel-6 Michael Freilich mission in late 2020 and its first operational data products, as well as the launch of Landsat 9, expanded the agency's data record. It opened up new capabilities in land and ocean research.

NASA scientists made several critical discoveries in studying Earth's changing climate. They determined that 2020 was the warmest year on record, quantified the impact of forests on the global carbon budget, completed the first global survey of freshwater fluctuation, and directed observations that confirm that humans are throwing Earth's energy budget off balance.

Goddard scientists also took to the field in challenging conditions balancing discovery and safety during the COVID-19 pandemic with campaigns such as SnowEx, Delta-X, and Sub-Mesoscale Ocean Dynamics Experiment (S-MODE).

Visit by Vice President Kamala Harris

The urgency of Earth science and climate studies took the spotlight on Nov. 5, 2021, as Vice President Kamala Harris visited Goddard's campus in Greenbelt, Maryland. The vice president received a first-hand look at how the nation's space program studies climate change and provides crucial information to understand our planet's changes and their impacts on our lives.

During the visit, NASA Administrator Bill Nelson unveiled the first images from Landsat 9. The images show Detroit with neighboring Lake St. Clair, a changing Florida coastline, and areas of Navajo Country in Arizona. They will add to the wealth of data helping to monitor crop health and water used for irrigation, manage vital natural resources, and track the impacts of climate change.

The images also provide data about the changing landscapes of the Himalayas and Australia, adding to Landsat's unparalleled data record that spans nearly 50 years of space-based Earth observation.

"I truly believe space activity is climate action. Space activity is education. Space activity is also economic growth. It is also innovation and inspiration. And it is about our security and our strength," the vice president said. "When it comes to our space activity, there is limitless potential. So, as we go forth from here, let us continue to seize the opportunity of space."

NASA, along with the National Oceanic and Atmospheric Administration (NOAA) and USGS, is among the federal agencies that conduct climate research and provide climate data critical for agencies and organizations worldwide. Extreme weather and climate events – including droughts, floods, and wildfires – are becoming regular occurrences. Insights from space help us study our planet as a unified system to understand these phenomena and benefit people where they live.

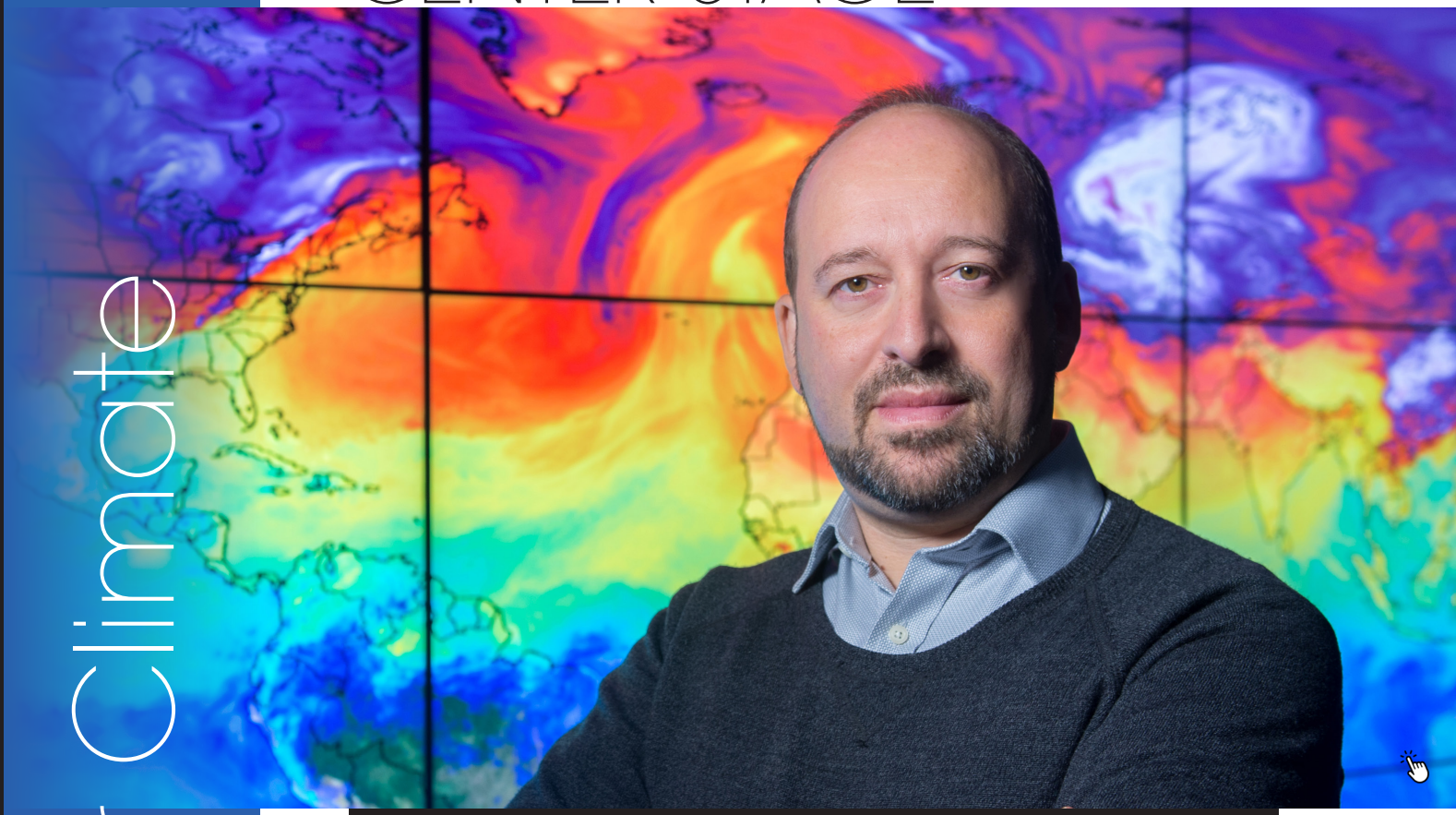
The vice president met with scientists and engineers to discuss how NASA's broad portfolio of Earth science missions helps address the climate challenges facing our world.

NASA's wide-ranging Earth science activities include satellites operated in partnership with other agencies. Those include NOAA and USGS, which also had representatives on hand to meet with Harris.

"Now in its sixth decade, the NOAA-NASA partnership puts the world's best technology in space to improve the nation's ability to monitor and predict Earth's climate and weather," said Rick Spinrad, NOAA administrator. "Teams of NOAA and NASA experts co-located at Goddard are advancing our nation's next-generation of geostationary satellites, called Geostationary Operational Environmental Satellites-R Series (GOES-R), which produce essential data for accurate and timely forecasts that save lives and help people adapt to climate change."

Harris also visited the Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission, which involves an instrument currently under construction at Goddard for a 2024 launch. PACE will advance assessment capabilities for ocean health by measuring the distribution of phytoplankton – tiny plants and algae that sustain the marine food web.

CLIMATE TAKES CENTER STAGE



GISS DIRECTOR SELECTED AS FIRST SENIOR CLIMATE ADVISOR

In an effort to ensure effective fulfillment of the Biden administration's climate science objectives for NASA, the agency established its first-ever senior climate advisor position in February 2021 and selected Gavin Schmidt, director of NASA's Goddard Institute for Space Studies (GISS) in New York, to serve in the role in an acting capacity until the permanent appointment of Dr. Katherine Calvin in January 2022.

Climate adaptation and mitigation efforts cannot succeed without robust climate observations and research. With more than two dozen satellites and instruments observing key climate indicators, NASA is the premier agency in observing and understanding changes to Earth. Furthermore, NASA enjoys broad public support and trust, lending credibility to its climate observations.

"One of 2021's successes was getting to know the depth and breadth of what NASA is doing in climate research," Schmidt said. "From sustainable aviation to dual-use space technology, the work that people are doing at the centers to really connect the data and models to the users is so impressive."

As a representative of the agency's strategic science objectives and accomplishments, the senior climate advisor advocates for NASA climate investments in the context of broader government agendas and works closely with the White House Office of Science and Technology Policy and the Office of Management and Budget.

The role of NASA's senior climate advisor is to:

- Promote and engage in climate-related investments in the NASA Science Mission Directorate's Earth Science Division,
- Promote aeronautics and other technology initiatives focused on reducing carbon dioxide emissions and broad climate impacts,
- Demonstrate and communicate the societal impacts and breadth of NASA investments related to climate,
- Foster communication and coordination within and outside the science community at NASA, and
- Actively engage in amplifying the agency's climate-related research and technological development.

Much of Schmidt's time in the role consisted of internal research and partnership building across the agency. Schmidt and his colleagues developed an upcoming report on how to improve the agency's overall climate strategy, including internal and external partnerships and communications to strengthen relationships that will foster additional discoveries. He wrote and appeared in media outlets ranging from The New York Times to Science, discussing climate science and modeling with a variety of audiences.

"The best surprise has been how great it all is and how keen everybody is to do more and bring up climate research across the agency," Schmidt said. "The broad desire to move everything forward has been extremely pleasing."

Schmidt has been GISS director since 2014. His main research interest is the use of climate modeling to understand past, present, and future climate change, and he has authored or co-authored more than 150 research papers in peer-reviewed literature. He is a fellow of the American Geophysical Union (AGU) and the American Association for the Advancement of Science. He was the inaugural winner of the AGU Climate Communication Prize in 2011, and he was awarded NASA's Outstanding Leadership Medal in 2017.

GISS is a laboratory in the Goddard Earth Sciences Division. A key objective of GISS research is the prediction of atmospheric and climate changes in the 21st century. The research combines analysis of comprehensive global data sets with global models of atmospheric, land surface, and oceanic processes. Study of past climate change on Earth and of other planetary atmospheres serves as a useful tool in assessing a general understanding of the atmosphere and its evolution.

Program areas at GISS are roughly divided into the categories of climate forcings; climate model development; Earth observations; atmospheric radiation; atmospheric chemistry; climate impacts; planetary atmospheres, exoplanets, and astrobiology; paleoclimate; and other disciplines. Most GISS personnel engage in research in several of these areas.

Calvin, appointed as permanent senior climate advisor as well as NASA chief scientist by NASA Administrator Bill Nelson in January 2022, has been an Earth scientist at the Pacific Northwest National Laboratory's Joint Global Change Research Institute in College Park, Maryland since 2008. Calvin served on a National Academy of Sciences research committee on models of the world, which was commissioned by the National Geospatial Intelligence Agency to create models for interrelated global systems such as economics, politics, and environment. She has contributed to the third U.S. National Climate Assessment as well as two special reports by the Intergovernmental Panel on Climate Change, with two more reports scheduled for publication in 2022.

NASA'S NEXT GREAT SPACE OBSERVATORY

THE JAMES WEBB SPACE TELESCOPE

In 1996, NASA set off to build a successor to the Hubble Space Telescope that would peer into the far reaches of the universe using infrared light. Engineers came up with a design that included an optical telescope element composed of 18 mirror segments, an integrated science instrument module containing four main science instruments, a spacecraft bus that provides support functions for the telescope's operations, and a sunshield that insulates the telescope's sensitive optics and science instruments from the heat of the Sun, Earth, and Moon.

The James Webb Space Telescope, renamed in 2002 after NASA's second administrator, has been in the making for more than 20 years. Following tests at NASA's Goddard Space Flight Center, the combined optical element and instrument module, known as OTIS, moved to NASA's Johnson Space Center in Houston in May 2017 for further testing.

It later went to Northrop Grumman's facilities in Redondo Beach, California, for final environmental testing and integration with the sunshield and spacecraft bus.

After much anticipation, Webb launched from the European Space Agency's Spaceport in Kourou, French Guiana, aboard an Ariane 5 rocket on Dec. 25, 2021.

Goddard is leading the team that is shepherding Webb through its commissioning – the process of readying the telescope for science observations. Once fully deployed, Webb will undergo the next steps of the commissioning process: aligning the telescope's mirrors, calibrating the telescope, and making sure all of its instruments are functioning properly.

After commissioning, Goddard will provide overall mission management, and the Space Telescope Science Institute in Baltimore will perform flight and science operations.

Once in orbit and commissioned for observations, Webb will begin to fulfill its science mission: to observe the formation of the first stars and galaxies, to help discover how galaxies have assembled and evolved over billions of years, to peer into cosmic nurseries to witness the formation of stars and planetary systems, and to analyze the atmospheres of exoplanets and potentially identify the building blocks of life.

Dr. John Mather will serve as Webb's senior project scientist. He was the co-recipient of the 2006 Nobel prize in physics for his work on the Cosmic Background Explorer, which helped validate the big-bang theory.

The James Webb Space Telescope, the scientific complement to NASA's Hubble Space Telescope, will be the premier space observatory of the next decade. Webb is an international project led by NASA with its partners, ESA (European Space Agency) and the Canadian Space Agency (CSA).

In addition to its international partners, Webb telescope has benefitted from the work of several contractors across the United States that have been integral parts of the observatory's assembly and testing, including Northrop Grumman, Ball Aerospace, and L3Harris Technologies.

For more information about the James Webb Space Telescope, visit www.jwst.nasa.gov.

2021 IN FIGURES

ONE GODDARD

MORE THAN 10,000 PEOPLE

3,000+ CIVIL SERVANTS

6,000+ ON-SITE CONTRACTORS

1,000+ OTHERS

(Including off-site contractors, emeritus employees and interns)

BUDGET: $4.8B

Direct GSFC Budget: $4.0B

Reimbursable GSFC Budget: $800M*

*From other government and nongovernment entities

Satellite Partners

7 AGENCIES

NASA

CSA ASC

DEPARTMENT OF DEFENSE

NOAA

esa

USGS science for a changing world

JAXA Japan Aerospace Exploration Agency

BEST PLACES TO WORK IN THE FEDERAL GOVERNMENT (2020 Rankings)

#1 NASA RANKED OUT OF 17 LARGE AGENCIES (Eighth Consecutive Year)

#26 GODDARD RANKED OUT OF 411 AGENCY SUBCOMPONENT ORGANIZATIONS

MORE THAN **20 Million** SOCIAL MEDIA FOLLOWINGS

Hubble Space Telescope

MORE THAN THREE DECADES IN ORBIT

OSIRIS-REx >60

GRAMS OF SOIL COLLECTED FROM ASTEROID SURFACE

LCRD

OPTICAL COMMUNICATIONS **10 to 100x** MORE BANDWIDTH THAN RADIO FREQUENCY SYSTEMS

10 SOLAR DYNAMICS OBSERVATORY STAMPS ISSUED BY U.S. POSTAL SERVICE

14 SOUNDING ROCKET LAUNCHES

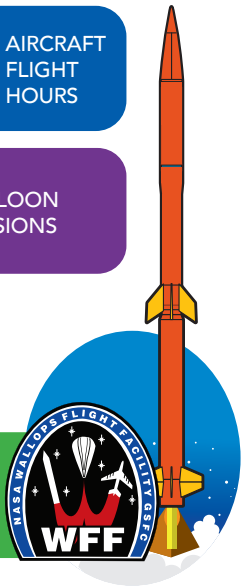
291 AIRCRAFT FLIGHT HOURS

1 NRO MISSION SUPPORTED

10 BALLOON MISSIONS

3 ISS RESUPPLY MISSIONS SUPPORTED

16,000+ LAUNCHES SINCE 1945



WALLOPS FLIGHT FACILITY

GODDARD VISITOR CENTERS

759 VIRTUAL TOURS

42,110 VIRTUAL VISITORS

COLUMBIA SCIENTIFIC BALLOON FACILITY

1,700+

BALLOONS LAUNCHED SINCE 1961 FOR:

35 Universities

23 Research Agencies

33 Foreign Groups

KATHERINE JOHNSON FACILITY

IV&V

15 NASA MISSIONS SUPPORTED

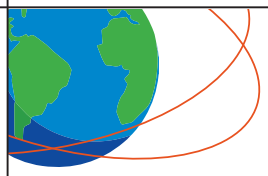
17 SEVERITY-ONE ISSUES IDENTIFIED

WEBB SPACE TELESCOPE

TRAVELING TO LAGRANGE POINT 2

1 MILLION MILES

FROM EARTH



50 YEARS

Landsat Partnership Between NASA and USGS

Solar and Heliospheric Observatory

25 YEARS IN ORBIT

Figures are for fiscal 2021 unless noted otherwise.

Our Focus Areas

THIS IS SCIENCE

EARTH SCIENCE

We observe and study Earth's system to further scientific understanding of our home planet and to improve predictions of its evolving state due to human behavior and natural changes.

ASTROPHYSICS

We investigate the universe through astronomy, astrophysics, and fundamental physics on issues such as dark matter and energy, life-harboring planets and black holes.

HELIOPHYSICS

We study the Sun and how it influences and affects the space environment – ours and those of the other planets in our solar system – and in turn, the technology we send into space.

PLANETARY SCIENCE

We investigate the planets, moons, and small objects in the solar system and beyond, including their evolution, inner structures, and forces that alter them.

SPACE COMMUNICATIONS AND NAVIGATION

We develop systems, technologies and services in support of science, exploration, and space operations missions that are near Earth and in deep space.

SUBORBITAL PROGRAMS AND RANGE SERVICES

We manage programs and services for sounding rockets, balloons, aircraft, and commercial space, including NASA's only owned-and-operated launch facility — Wallops Launch Range.

CROSS-CUTTING TECHNOLOGIES

Sensor Systems and Instrument Platforms

Goddard builds instruments for missions, ranging from subsystems – such as detectors and optical elements – to full instruments and complex instrument suites.

Large-Scale Scientific Information Systems, Data Processing, and Dissemination

Goddard designs and implements custom, large-scale data systems, and supercomputing applications for high-performance computing and archiving of a wide range of science data.

Orbital Servicing and Assembly

Goddard services enable extended mission operations, reconfiguration, and recovery, including in-orbit spacecraft refueling and repair, assembling large structures in orbit, and enabling modular designs.

OTHER ENABLING CAPABILITIES

Program and Project Management

Goddard conducts effective, tailored management and cost estimation, maintains schedules, develops technology, manages risk, and ensures outcomes for missions and their supporting elements and services.

End-to-End Mission Systems Architecture and Engineering

Goddard addresses the full life cycles of science missions, spacecraft, in situ and remote-sensing instruments, and payloads, from advanced concepts through implementation.

Safety and Mission Assurance

Goddard is a recognized leader in safety and mission assurance with a lengthy history of implementing effective and innovative approaches to reduce risk and enable mission success.

HUMAN EXPLORATION

SUPPORTING THE PAST, PRESENT, AND FUTURE OF HUMAN SPACEFLIGHT

Dating back to its beginnings, NASA's Goddard Space Flight Center has supported the agency's human spaceflight endeavors, from Project Mercury and the Apollo missions to the Space Shuttle Program and today's International Space Station expeditions. The center remains vital to NASA's human exploration initiatives, including the recent missions of the Commercial Crew Program and the upcoming Artemis missions, which will send the first woman and first person of color to the Moon in preparation for eventually sending humans to Mars.

Scientific Research

Planetary Science

Data products from the Lunar Reconnaissance Orbiter, including high-resolution images and topographic maps, will help determine safe landing sites and Artemis science objectives. Our scientists are active in the lab and field, the results of which provide valuable input to the design of new science instruments, as well as hardware and strategies to be used by astronauts.

HUMAN EXPLORATION

Space Weather Research

Goddard heliophysics missions provide detailed data about the space environment and radiation encircling the Sun, Earth and Moon. This helps scientists model conditions of the very space we travel through, which helps keep astronauts, instruments and spacecraft safe from harsh environments. Goddard is also building one of the first instrument suites, HERMES, for the lunar Gateway to enhance our ability to forecast space weather.

In-orbit Servicing and Assembly

Goddard is developing servicing technologies that are critical to sustainable human exploration. The capabilities will allow spacecraft to live longer and journey farther. We also develop important tools that help enable a sustained human presence in space. From astronaut tools for instrument repairs to robotic tools for leak detection and other operations, we ensure NASA has the right tools to maintain astronaut habitats in space. Currently used aboard the International Space Station, these tools can be applied to future exploration missions and human habitats on the Moon, Mars and beyond.

Space Communications and Navigation

Communications Services

Goddard's communications and navigation community oversees NASA's Near Space Network, which provides critical services to missions within 2 million kilometers of Earth through a blend of government and commercial providers. The network supports demonstrations, human spaceflight, science, and robotic missions, giving them the essential services they need for tracking, telemetry, and control, as well as for returning data to Earth for investigation and discovery. The network, along with the new commercialization office, is embracing the agency's goal for increased commercialization, enabling a robust communications and navigation marketplace.

Navigation Services

Goddard's Flight Dynamics Facility provides missions with comprehensive and reliable navigation services. The facility uses tracking data to ensure the success and safety of a variety of missions, including those in human spaceflight. In the unlikely event of a launch abort, the facility has developed new tools, software, and operations concepts to ensure missions stay connected to mission operations centers on Earth. Navigation experts are also designing the satellite navigation systems and architectures of the future while serving as navigation experts on the international stage.

Search and Rescue

For the international satellite-aided search and rescue effort, Goddard's Search and Rescue office develops emergency beacons and the flight and ground systems that support them. These technologies support Earth-based search and rescue, as well as astronaut safety. The office is currently expanding this technology for NASA's Artemis astronauts.

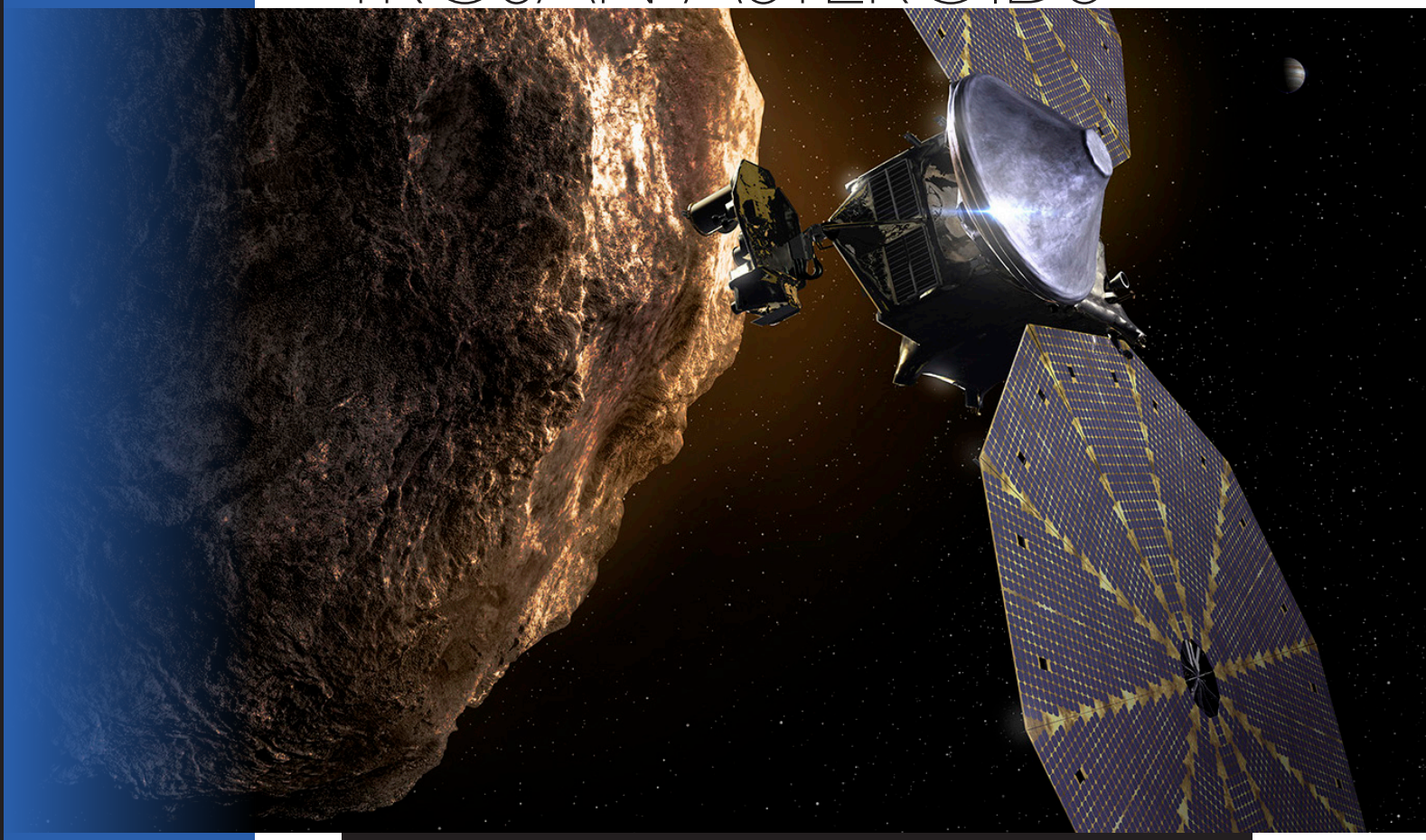
Communications and Navigation Technology Development

The communications and navigation community also investigates and develops new and innovative technologies that can enhance our networking and tracking capabilities. These include optical and quantum communications, autonomous navigation, LunaNet and LunaSAR, and more.

Wallops Flight Facility Support

Wallops Flight Facility has long enabled NASA's human spaceflight efforts through telemetry and tracking support for the Space Shuttle Program and now the Commercial Crew Program. Since 2013, Wallops has launched resupply missions to the International Space Station, carrying scientific investigations, technology demonstrations and supplies to astronauts aboard the orbiting laboratory.

LUCY: A MISSION TO THE TROJAN ASTEROIDS



SEARCHING FOR DIAMONDS IN THE SKY

NASA's Lucy mission is the first space mission to explore a diverse population of small bodies known as the Jupiter Trojan asteroids. These small bodies are remnants of our early solar system, now trapped on stable orbits associated with – but not close to – the giant planet Jupiter.

The mission launched in October 2021 aboard a United Launch Alliance (ULA) Atlas V rocket from Space Launch Complex 41 at Cape Canaveral Space Force Station in Florida.

Over the next 12 years, Lucy will fly by one main-belt asteroid and seven Trojan asteroids, making it the agency's first single spacecraft mission in history to explore so many different asteroids. Lucy will investigate these "fossils" of planetary formation up close during its journey.

"Lucy embodies NASA's enduring quest to push out into the cosmos for the sake of exploration and science, to better understand the universe and our place within it," said NASA Administrator Bill Nelson.

Named for the fossilized skeleton of one of our earliest known hominin ancestors, the Lucy mission will allow scientists to explore two swarms of Trojan asteroids that share an orbit around the Sun with Jupiter. Studying the asteroids can reveal previously unknown information about their formation and our solar system's evolution in the same way the fossilized skeleton of Lucy revolutionized our understanding of human evolution.

In order to understand the diversity of the Trojan asteroids, Lucy has the following science objectives at each of its destinations:

- Surface Geology – Lucy will map the shape, albedo, and crater spatial and size-frequency distributions; determine the nature of crustal structure and layering; and determine the relative ages of surface units.
- Surface Color and Composition – Lucy will map the color, composition, and regolith properties of the surface and determine the distribution of minerals, ices, and organic species.
- Interiors and Bulk Properties – Lucy will determine the masses and densities, and study subsurface composition via excavation by craters, fractures, ejecta blankets, and exposed bedding.
- Satellites and Rings – Lucy will look for and study satellites and/or rings of the targeted Trojan asteroids.

"We started working on the Lucy mission concept early in 2014, so this launch has been long in the making," said Hal Levison, Lucy principal investigator based out of the Boulder, Colorado, branch of the Southwest Research Institute (SwRI), which is headquartered in San Antonio, Texas. "It will still be several years before we get to the first Trojan asteroid, but these objects are worth the wait and all the effort because of their immense scientific value. They are like diamonds in the sky."

Lucy's Trojan destinations are trapped near Jupiter's Lagrange points – gravitationally stable locations in space associated with a planet's orbit where smaller masses can be trapped. One swarm of Trojans is ahead of the gas giant planet, and another is behind it. The asteroids in Jupiter's Trojan swarms are as far away from Jupiter as they are from the Sun.

The spacecraft's first Earth-gravity assist in 2022 will accelerate and direct Lucy's trajectory beyond the orbit of Mars. The spacecraft will then swing back toward Earth for another gravity assist in 2024, which will propel Lucy toward the Donaldjohanson asteroid – located within the solar system's main asteroid belt – in 2025.

Lucy will then journey toward its first Trojan asteroid encounter in the swarm ahead of Jupiter for a 2027 arrival. After completing its first four targeted flybys, the spacecraft will travel back to Earth for a third gravity boost in 2031, which will catapult it to the trailing swarm of Trojans for a 2033 encounter.

Lucy is equipped with a suite of remote sensing instruments, including L'Ralph, an instrument provided by NASA's Goddard Space Flight Center consisting of two parts:

- L'Ralph Linear Etalon Imaging Spectral Array (LEISA), an infrared imaging spectrometer that will reveal the absorption lines that serve as the fingerprints for different silicates, ices, and organics that may be on the surface of the Trojan asteroids, and
- L'Ralph Multi-spectral Visible Imaging Camera (MVIC) that will take color images of the Trojans to help determine their composition and look for indications of surface activity.

Goddard provides overall mission management, systems engineering, plus safety and mission assurance. The Lucy principal investigator institution is based out of the Boulder, Colorado, branch of SwRI. Lockheed Martin Space in Littleton, Colorado, built the spacecraft. Lucy is the 13th mission in NASA's Discovery Program. NASA's Marshall Space Flight Center in Huntsville, Alabama, manages the Discovery Program for the agency.

WALLOPS FLIGHT FACILITY

A ONE-OF-A-KIND NATIONAL ASSET

NASA's Wallops Flight Facility in Wallops Island, Virginia provides agile, low-cost flight and launch range services to meet government and commercial sector needs for accessing flight regimes from Earth's surface to the Moon and beyond. Wallops' flight resources include research aircraft, remotely piloted aerial systems, high-altitude balloons, and suborbital and orbital rockets providing a range of capabilities. The facility's launch range and airfield capabilities meet ongoing and emerging flight needs for science, aerospace, defense, and commercial industries.

During 2021, Wallops logged nearly 300 science-flight hours using research aircraft and launched 14 sounding rockets. The Scientific Balloon Program saw its first flights since the COVID-19 pandemic began, launching 10 balloons. The balloon and sounding rocket flights supported Mars entry, descent, and landing (EDL) technology demonstration by flying to

WALLOPS FLIGHT FACILITY

altitudes where the atmospheric density closely mimics that of the Martian atmosphere. The hallmark of Wallops' suborbital program offer the ability to "go where the science is."

Each flight platform is suited for specific altitudes. Research aircraft and remotely piloted aerial systems go as high as 11 miles up. Scientific balloons can reach up to 30 miles, and sounding rockets can exceed 1,000 miles. These vehicles can be deployed from locations around the world. For example, sounding rockets routinely fly from Poker Flat Research Range in Alaska, which is well-suited for studying the aurora borealis and its effects on communications.

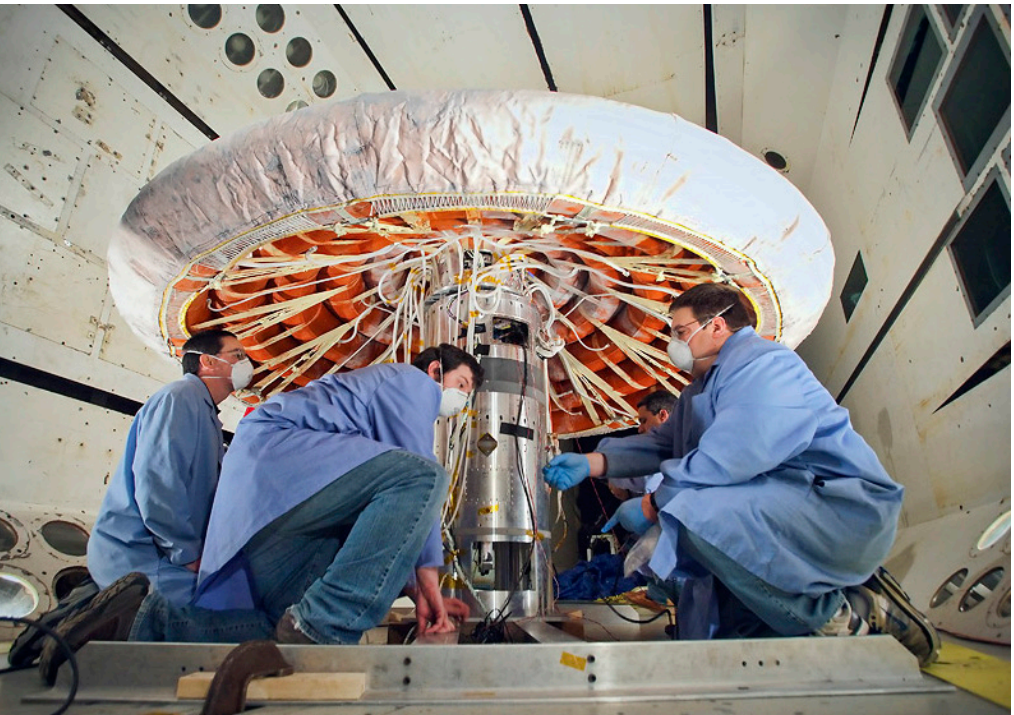
While the agency's suborbital programs don't always make headlines, the missions support numerous science and exploration initiatives. Sounding rocket and balloons are key for providing an in-depth understanding of planetary and astrophysical processes and phenomena, which supports our understanding of the universe and expanding exploration of the solar system. Sounding rockets in particular expand our understanding of Sun-Earth interactions vital for protecting national infrastructure such as power, communication, and space resources.

These programs provide validation of the technology readiness level for EDL systems in higher levels of the atmosphere, technologies that will one day enable the exploration distant solar bodies.

Wallops' research aircraft program supports Earth science research, expanding our understanding of Earth's systems and processes. Research aircraft are also improving aeronautics capabilities and technologies that support commercial and defense aviation.

Supporting all of this work is the Wallops Research Range, one of just four major launch sites in the United States capable of launching payloads into orbit. The Range and Mission Management Office provides command and control, enabling routine access to space.

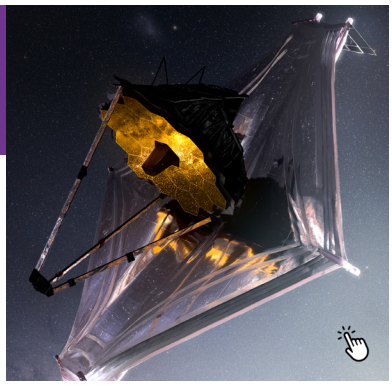
Wallops was founded in 1943 as a naval air station. The first launch from the site occurred in June 1945. Since the early days as a facility for conducting high-speed research on aerodynamic designs, Wallops has launched more than 16,000 rockets carrying aircraft models, space and Earth science experiments, technology development payloads, and satellites.



HIGHLIGHTS OF FISCAL 2021

WEBB

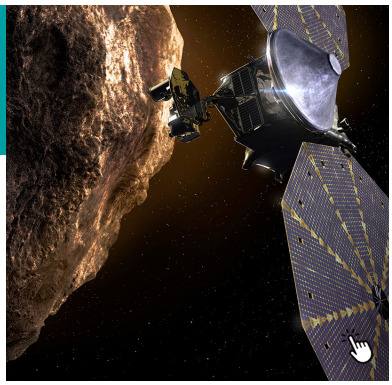
ASTRO



After launching on Dec. 25, 2021, the James Webb Space Telescope is on its way to becoming the world's premier space science observatory – solving mysteries in our solar system, looking beyond to distant worlds around other stars, and probing the mysterious structures and origins of our universe and our place in it. Testing was completed in August 2021, and Webb was shipped to its launch site in French Guiana in October. Observatory deployments began in late December following the launch.

LUCY

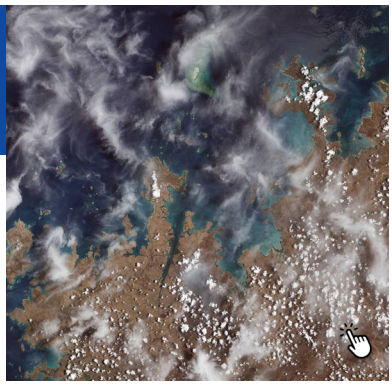
PLANETARY



NASA's Lucy mission launched en route to the Trojan asteroids in October 2021 from Cape Canaveral Space Force Station in Florida. During its 12-year primary mission, Lucy – named after the fossilized skeleton of a prehuman ancestor – will explore a record-breaking number of asteroids, flying by one main belt asteroid and seven Trojan asteroids. The mission may revolutionize humanity's knowledge of planetary origins and the formation of the solar system.

LANDSAT 9

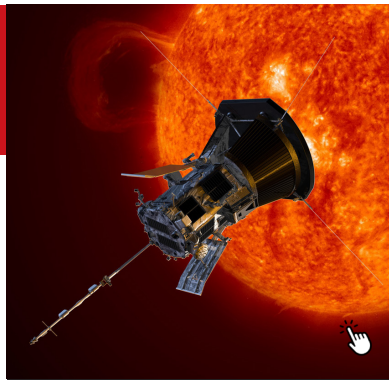
EARTH



Landsat 9, a joint mission between NASA and the U.S. Geological Survey, launched in September 2021 as the next spacecraft in the nearly 50-year Landsat partnership between the two agencies. The first images from Landsat 9 were acquired about a month after launch, showing how the latest addition will continue the program's role in helping people monitor, understand, and manage the land resources needed to sustain human life. It is working closely in tandem with its predecessor, Landsat 8, to collect a wealth of data on our changing planet.

PARKER SOLAR PROBE

HELIO



NASA's Parker Solar Probe became the first spacecraft to "touch" the Sun in April 2021, flying through its upper atmosphere – the corona – and sampling particles and magnetic fields. As it circles close to the solar surface, Parker is making new discoveries that other spacecraft were too far away to see, such as how magnetic zig-zag structures – switchbacks – in the solar wind are plentiful near the surface. The latest milestone will help scientists uncover critical information about our closest star and its influence on the solar system.

HIGHLIGHTS OF FISCAL 2021

OSIRIS-REX

PLANETARY

The Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer (OSIRIS-REx) launched in 2016 to return a sample from the near-Earth asteroid Bennu. The collection site – named "Nightingale" – on the asteroid was selected in December 2019. The sample was collected in October 2020 and will be returned to Earth by 2023, giving scientists greater insight into the formation and evolution of the solar system.

HUBBLE

ASTRO

Following a computer anomaly that suspended observations by the Hubble Space Telescope for more than a month, the Goddard operations team restored the telescope to science operations in July 2021, allowing it to continue exploring the universe near and far. Now entering its 32nd year of operations, Hubble has revolutionized humanity's understanding of the universe through countless discoveries and memorable images, taking more than 1.5 million observations since its launch in 1990. It is NASA's most productive science mission to date.

LCRD

COMM & NAV

NASA's Laser Communications Relay Demonstration (LCRD) was sent into space in December 2021 from Cape Canaveral Space Force Station in Florida as part of the U.S. Space Force's Space Test Program 3 mission. LCRD continues Goddard's long-standing role in space communications, demonstrating the agency's first two-way laser communications relay system by sending and receiving data over infrared lasers. This technology can enable data rates 10 to 100 times greater than traditionally used radio frequency systems.

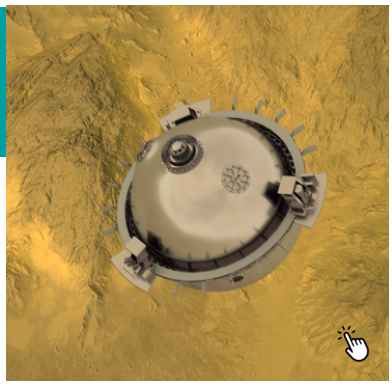
WALLOPS LAUNCHES

SUBORBITAL

Continuing its long-standing role in resupply missions to the space station, Wallops Flight Facility supported Northrop Grumman Antares launches – carrying Cygnus resupply spacecraft – to the station in October 2020, February 2021, and August 2021. In addition, Wallops supported the launch of a Minotaur I rocket carrying a national security payload for the National Reconnaissance Office – the agency's second dedicated launch from the facility in June 2021, following a successful first launch in July 2020.

HIGHLIGHTS OF FISCAL 2021

DAVINCI
PLANETARY

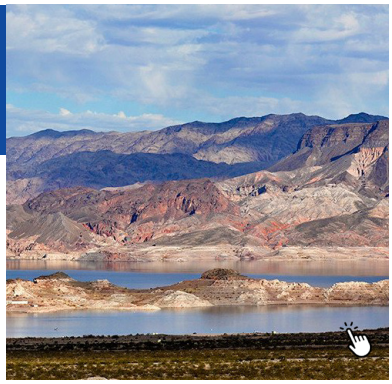


NASA selected the Deep Atmosphere Venus Investigation of Noble-gases, Chemistry, and Imaging mission (DAVINCI) as part of its Discovery program in June 2021. DAVINCI will be the first U.S. probe mission to enter Venus' atmosphere in over 40 years. Named for visionary Renaissance artist and scientist Leonardo da Vinci, DAVINCI may reveal whether Earth's neighbor looked more like Earth's twin planet with oceans and continents in a distant, possibly hospitable past.

RRM3
TECHNOLOGY

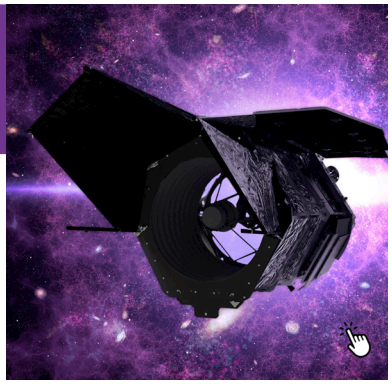
NASA's Robotic Refueling Mission 3 (RRM3) completed its second set of robotic tool operations aboard the space station in October 2020, demonstrating key tools and techniques for transferring cryogenic fluids, which can be used as coolants, propellants, or for life-support systems in orbit. These technologies have applications for extending spacecraft life and facilitating future exploration to the Moon and Mars. The latest set of operations focused on testing the connection of a fluid hose and the visual verification of the insertion of the hose into a port.

ICESAT-2
EARTH



Scientists have conducted the first global accounting of fluctuating water levels in Earth's lakes and reservoirs – including ones previously too small to measure from space – using data from NASA's Ice, Cloud and land Elevation Satellite 2 (ICESat-2), which launched in 2018. The research, published in March 2021, demonstrates how much humans are altering the global hydrological cycle. The results of the study will aid future investigations into how the relationship between human activity and climate affects the availability of freshwater.

ROMAN
ASTRO



The Nancy Grace Roman Space Telescope passed its critical design review in September 2021, signaling the completion of all design engineering work and allowing the team to continue building and then testing the observatory in preparation for a 2027 launch. Roman will peer across vast stretches of space and time to survey the infrared universe, allowing astronomers to observe planets by the thousands, galaxies by the millions, and stars by the billions, as well as shed light on the mysteries of dark energy and dark matter.

THIS IS WHAT WE DO

A PLACE FOR SUCCESS

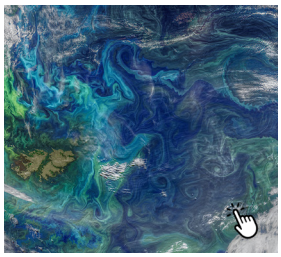
We help answer crucial science questions through complex missions that depend on dedicated and innovative teams to develop pioneering technologies. Goddard is one of the few organizations worldwide that manages missions from the concept phase through operations, utilizing internal, partner, and industry expertise and resources along the way.

The depth and expertise of our scientists, engineers, technologists, project managers, and support personnel form the foundation of our unique strength. With our leadership in scientific research and instrument and spacecraft development, the center has a renowned capability to conceive and manage advanced science, technology, and space systems through the entire mission life cycle.

EARTH SCIENCE

science.gsfc.nasa.gov/earth

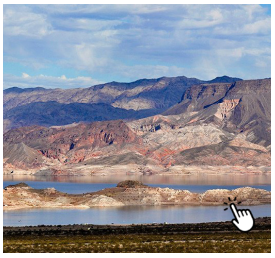
The Goddard Earth Sciences Division plans, organizes, evaluates, and implements a broad program of research on our planet's natural systems and processes to meet the challenges of environmental change and to improve life on Earth. The largest Earth sciences unit within NASA, the division looks at Earth as an environmental system, addressing questions related to how the components of that system have developed, how they interact and how they continue to evolve.

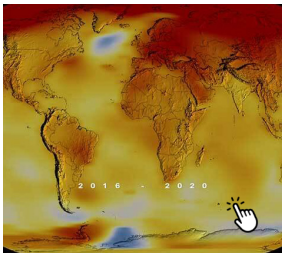


Combined Budget: $925.3M

Combined Goddard Budget Percentage: 19.1%

- **Facilities:**
  - **Greenbelt**
  - **Wallops**
  - **GISS**
- **13 Labs/Offices**
- **1,400+ Staff**





Missions and Instruments

CONCEPT DEVELOPMENT

- Atmospheric Observing System (AOS)
- Landsat NeXT

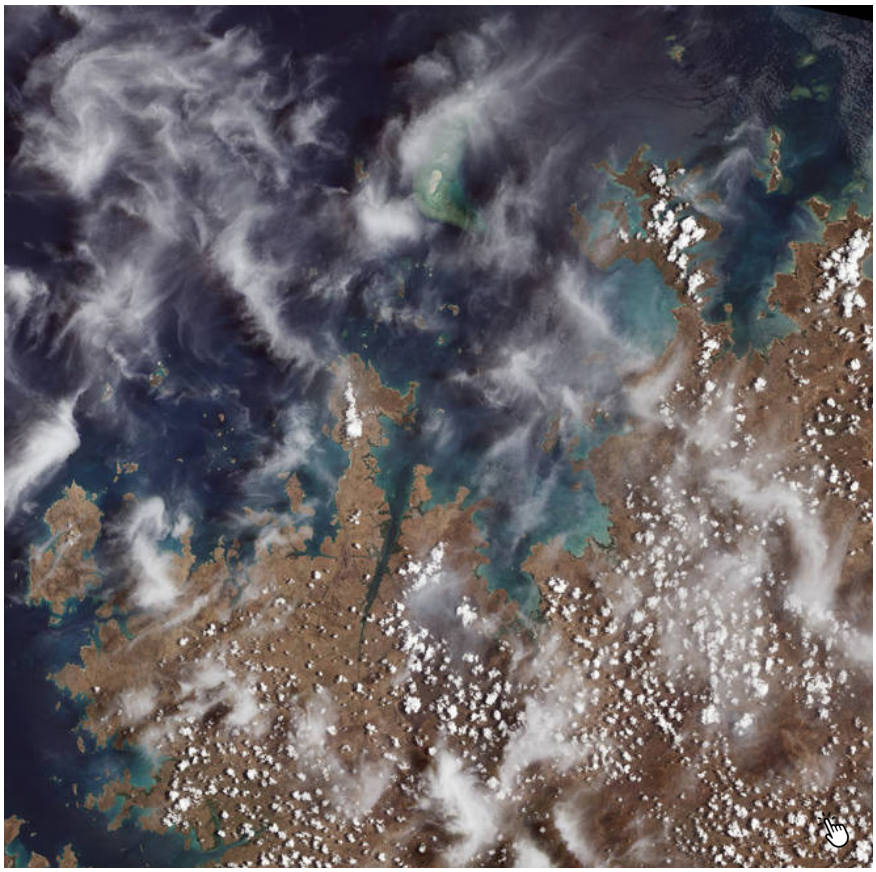
IN DEVELOPMENT

- Climate Absolute Radiance and Refractivity Observatory (CLARREO) Pathfinder
- Geostationary Carbon Cycle Observatory (GeoCarb)
- Geostationary Operational Environmental Satellites T (GOES-T)*
- Joint Polar Satellite System-2 (JPSS-2)*
- Ozone Mapping and Profiler Suite (OMPS)-Limb profiler*
- Plankton, Aerosol, Cloud, ocean Ecosystem (PACE)
- Total and Spectral Solar Irradiance Sensor-2 (TSIS-2)

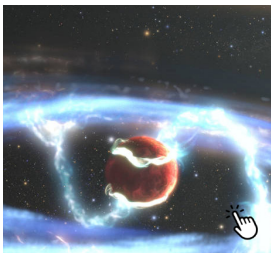
OPERATIONAL

- Aqua
- Aura
- Deep Space Climate Observatory (DSCOVR)*
- Global Ecosystem Dynamics Investigation (GEDI)
- Global Precipitation Measurement Mission (GPM)*
- GOES-14*, GOES-15*, GOES-16 (GOES East)*, GOES-17 (GOES West)*
- Ice, Cloud, and land Elevation Satellite-2 (ICESat-2)
- Joint Polar Satellite System-1 (JPSS-1/NOAA-20)*
- Landsat 7*, Landsat 8*, Landsat 9*
- Meteorological operational satellite-C (Metop-C)*
- Soil Moisture Active Passive (SMAP) Radiometer
- Suomi-National Polar-orbiting Partnership (Suomi-NPP)*
- Terra
- Total and Spectral Solar Irradiance Sensor (TSIS-1)

**Joint agency satellite*



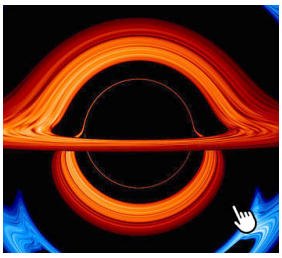
ASTROPHYSICS

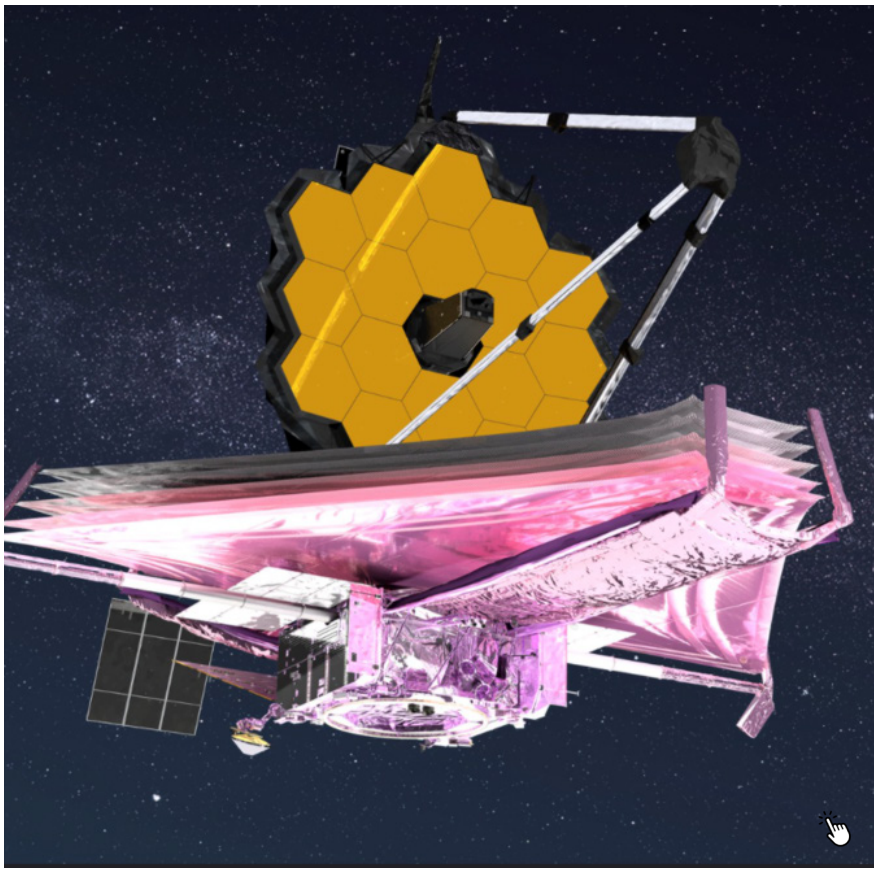


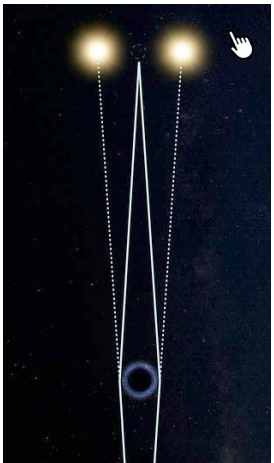
Budget: $1.21B

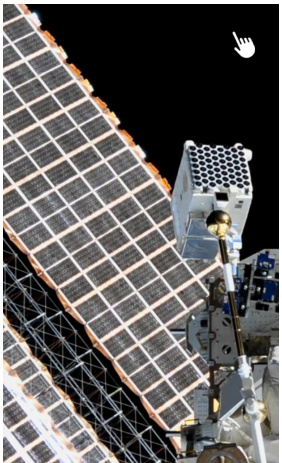
Goddard Budget Percentage: 25.0%

- **Facility:**
  - **Greenbelt**
- **8 Labs/Offices**
- **370 Staff**









The Goddard Astrophysics Science Division comprises eight specialized laboratories and offices. Its major focus areas include the nature of dark matter and dark energy, the search for habitable planets outside our solar system, the origin and evolution of the universe, and the nature of space and time at the edges of black holes.

Missions and Instruments

IN DEVELOPMENT

- Advanced Telescope for High Energy Astrophysics (ATHENA)*
- BurstCube
- Experiment for Cryogenic
- Large-Aperture Intensity Mapping (EXCLAIM)
- James Webb Space Telescope (JWST)
- Laser Interferometer Space Antenna (LISA)*
- Nancy Grace Roman Space Telescope (RST)
- X-Ray Imaging and Spectroscopy
- Mission (XRISM)*
- Pandora

OPERATIONAL

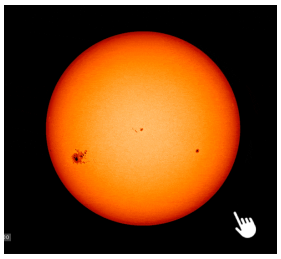
- Balloon-borne Cryogenic Telescope Testbed (BOBCAT)
- CALorimetric Electron Telescope (CALET)*
- Fermi Gamma-ray Space Telescope
- Hubble Space Telescope
- International Gamma-Ray Astrophysics Laboratory (INTEGRAL)*
- Neil Gehrels Swift Observatory
- Neutron star Interior Composition ExploreR (NICER)
- Nuclear Spectroscopic Telescope Array (NuSTAR)
- Primordial Inflation Polarization Explorer (PIPER)
- Super Trans-Iron Galactic Element Recorder (SuperTIGER)
- Transiting Exoplanet Survey Satellite (TESS)
- X-ray Multi-Mirror Mission (XMM-Newton)*

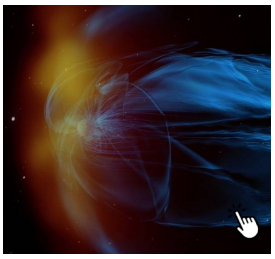
**Joint agency satellite*

HELIOPHYSICS

science.gsfc.nasa.gov/heliophysics

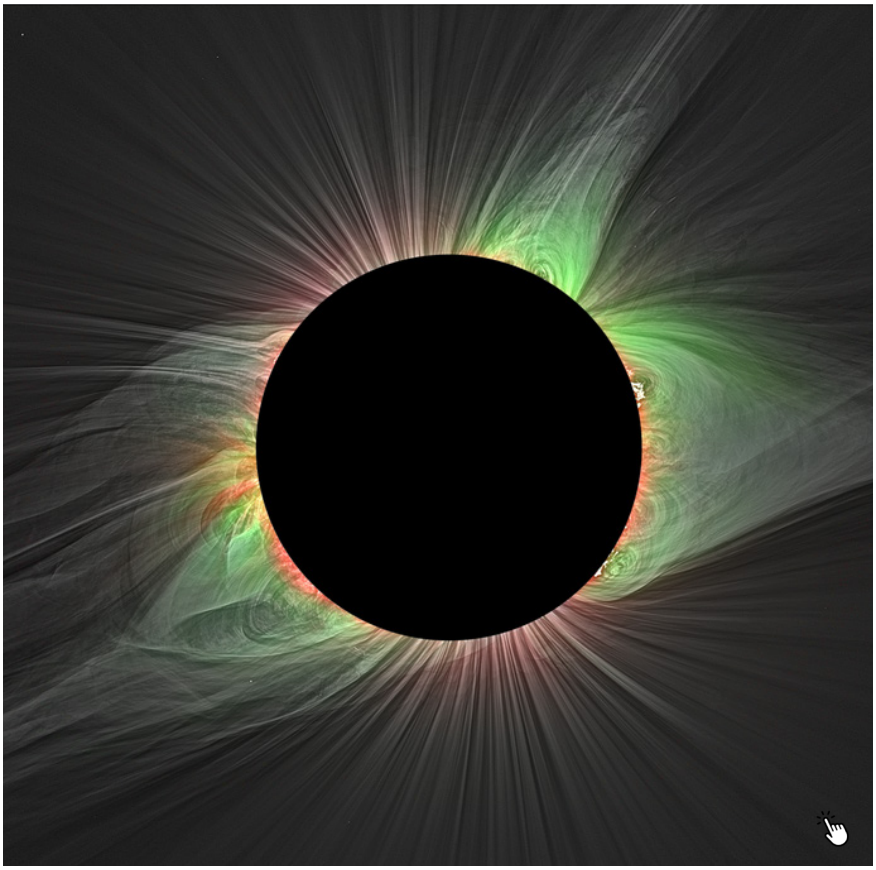
Space seethes with energy, magnetic fields, and countless particles, many of which come from the Sun. This radiation and magnetic energy can affect Earth's atmosphere, spacecraft, radio communications, and astronauts. Understanding the environment surrounding Earth is critical for protecting satellites and helps us learn more about the space through which astronauts travel. Goddard conducts research on the Sun and how its output modifies space throughout the solar system.





Budget: $313.5M

Goddard Budget Percentage: 6.5%



Missions and Instruments

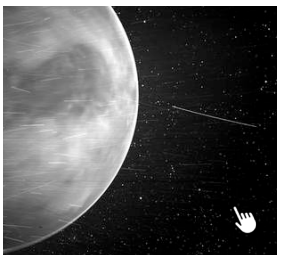
IN DEVELOPMENT

- Atmospheric Waves Experiment (AWE)
- Coronal Diagnostic Experiment (CODEX)*
- Electrojet Zeeman Imaging Explorer (EZIE)
- Escape and Plasma Acceleration and Dynamics Explorers (ESCAPADE)
- Extreme Ultraviolet High-Throughput Spectroscopic Telescope Epsilon Mission (EUVST)*
- Geospace Dynamics Constellation (GDC)
- Global Lyman-alpha Imagers of the Dynamic Exosphere (GLIDE)
- Heliophysics Environmental and Radiation Measurement Experiment Suite (HERMES)
- Interstellar Mapping and Acceleration Probe (IMAP)
- Polarimeter to Unify the Corona and Heliosphere (PUNCH)
- Solar Cruiser
- Spatial/Spectral Imaging of Heliospheric Lyman Alpha (SIHLA)
- Sun Radio Interferometer Space Experiment (SunRISE)
- Tandem Reconnection and Cusp Electrodynamics Reconnaissance Satellites (TRACERS)

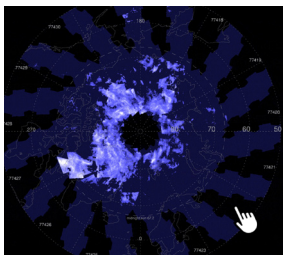
OPERATIONAL

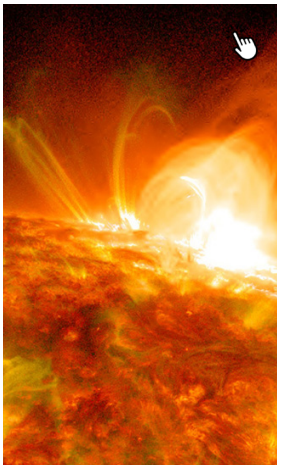
- Advanced Composition Explorer (ACE)
- Aeronomy of Ice in the Mesosphere (AIM)
- Deep Space Climate Observatory (DSCOVR)*
- Geotail*
- Global Observations of the Limb and Disk (GOLD)
- Hinode*
- Interface Region Imaging Spectrograph (IRIS)
- Interstellar Boundary Explorer (IBEX)
- Ionospheric Connection Explorer (ICON)
- Magnetospheric Multiscale (MMS)
- Parker Solar Probe (managed by Johns Hopkins University Applied Physics Laboratory)
- Solar and Heliospheric Observatory (SOHO)*
- Solar Dynamics Observatory (SDO)
- Solar Orbiter*
- Solar Terrestrial Relations Observatory (STEREO)
- Thermosphere Ionosphere Mesosphere Energetics and Dynamics (TIMED)
- Time History of Events and Macroscale Interactions during Substorms (THEMIS/ARTEMIS)
- Wind

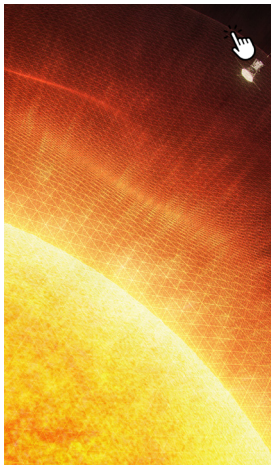
**Joint agency satellite*

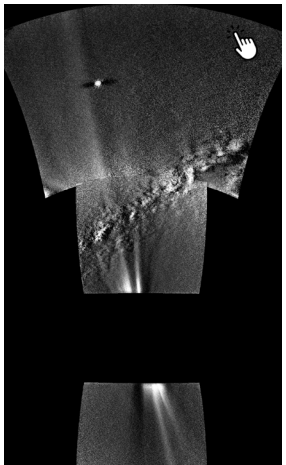


- **Facilities:**
  - **Greenbelt**
  - **Wallops**
- **5 Labs/Offices**
- **350+ Staff**



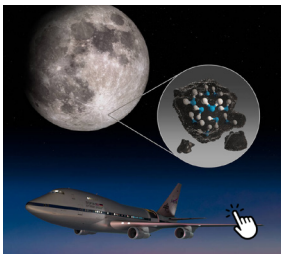


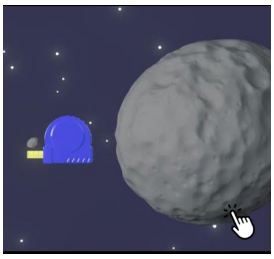




PLANETARY SCIENCE

science.gsfc.nasa.gov/solarsystem

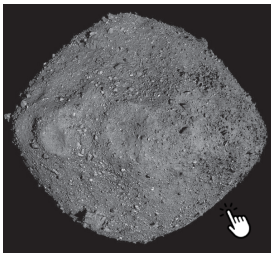


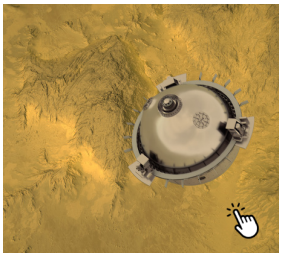


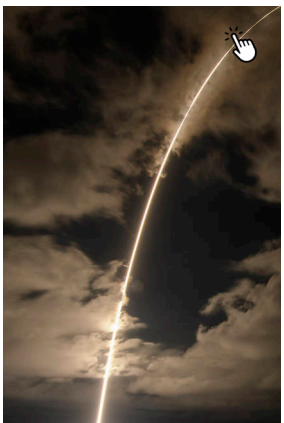
Budget: $418.2M

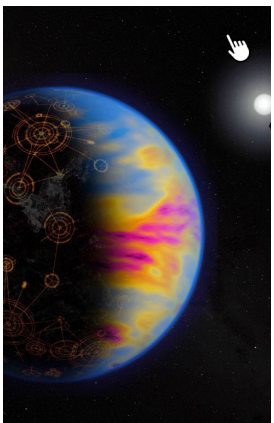
Goddard Budget Percentage: 8.6%

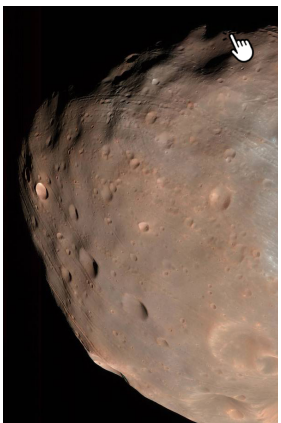
- **Facility:**
  - **Greenbelt**
- **6 Labs/Offices**
- **356 Staff**











With more than 50 years of experience in designing and building instruments for spaceflight, the Goddard Solar System Exploration Division conducts theoretical and experimental research to explore the solar system and understand the formation and evolution of planetary systems. Its research encompasses areas as diverse as astrochemistry, planetary atmospheres, extrasolar planetary systems, planetary geology and comparative planetary studies.

Missions and Instruments

IN DEVELOPMENT

- Commercial Lunar Payload Services instruments (6)
- Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging (DAVINCI)
- Dragonfly Gamma-Ray and Neutron Spectrometer (DraGNS)
- Geostationary Operational Environmental Satellites-T (GOES-T) magnetometer
- Dragonfly Mass Spectrometer (DraMS)
- Mars Organic Molecule Analyzer Mass Spectrometer (MOMA-MS)
- Search coils on Beam Plasma Interaction Experiment (BeamPIE)
- Search coils on Space Measurement of A Rocket-release Turbulence (SMART) mission
- Venus Mass Spectrometer (VMS)

OPERATIONAL

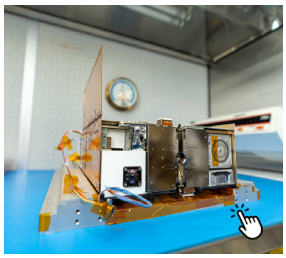
- Lucy, Linear Etalon Imaging Spectral Array (LEISA), L'Ralph
- Lunar Reconnaissance Orbiter (LRO) and Lunar Orbiter Laser Altimeter (LOLA)
- Magnetometers on Deep Space Climate Observatory (DSCOVR), Advanced Composition Explorer (ACE), Juno, Van Allen Probes, Voyager and Parker Solar Probe
- Mars Atmosphere and Volatile EvolutioN mission (MAVEN)
- Neutral Gas and Ion Mass Spectrometer (NGIMS), Magnetometer (MAG)
- Origins, Spectral Interpretation, Resource Identification, Security Regolith Explorer (OSIRIS-REx) and OSIRIS-REx Visible and Infrared Spectrometer (OVIRS)
- Sample Analysis at Mars (SAM)
- Search coils on U.S. Air Force Demonstration and Science Experiments (DSX)
- Thermal Infrared Sensor (TIRS)
- Thermal Infrared Sensor-2 (TIRS-2)

SPACE COMMUNICATIONS AND NAVIGATION

esc.gsfc.nasa.gov

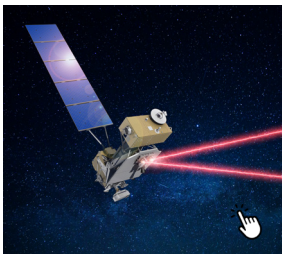
Goddard's communications and navigation experts provide robust networking and tracking services as well as develop cross-cutting technical solutions that drive NASA forward. This year, the community established NASA's new Near Space Network, which provides services to near-Earth missions through a blend of government and commercial providers - fully embracing NASA's goal for commercialization. Additionally, the community enhances and develops new technologies to advance NASA's space communications and navigation capabilities. The work accomplished this year will directly impact agency initiatives such as the Artemis program and future endeavors to Mars.

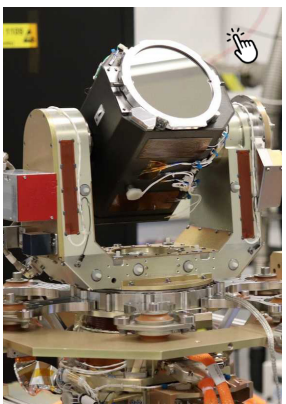
Facilities:
- **Greenbelt**
- **Wallops**
- **White Sands**



Budget: $242.9M

Goddard Budget Percentage: 5.0%





Missions and Instruments

IN DEVELOPMENT

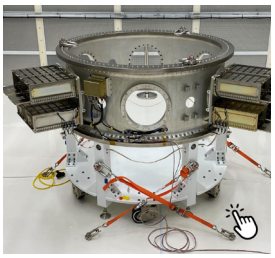
- Lunar IceCube
- Terabyte Infrared Delivery (TBIRD)
- Integrated LCRD LEO User Modem and Amplifier Terminal (ILLUMA-T)
- Orion Artemis II Optical Communications System (O2O)
- Lunar GNSS Receiver Experiment (LuGRE)

OPERATIONAL

- Laser Communications Relay Demonstration (LCRD)
- Tracking and Data Relay Satellite-3, 5-13 (TDRS-3, 5-13)

SUBORBITAL PROGRAMS AND RANGE SERVICES

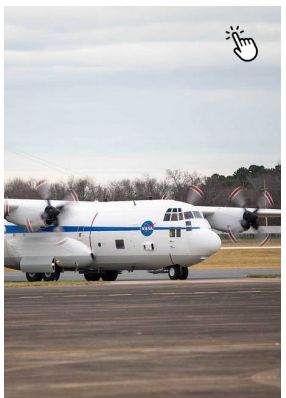
nasa.gov/wallops



Budget: $153.9M

Goddard Budget Percentage: 3.2%

- **Facilities:**
  - **Columbia Scientific Balloon Facility**
  - **Wallops**
  - **White Sands**
- **4 NASA Aircraft**
- **1,100+ Staff**



Thanks to NASA's Wallops Flight Facility, Goddard provides agile, low-cost flight and launch range services for meeting government and commercial sector needs for accessing flight regimes from Earth's surface to the Moon and beyond. Assets include research aircraft, remotely piloted aerial systems, high-altitude balloons, suborbital and orbital rockets.

Missions and Instruments

IN DEVELOPMENT

- Space station cargo resupply missions (2)
- Certification of the NASA Autonomous Flight Termination Unit (NAFTU)
- Rocket Lab's first flight from Wallops
- Scientific balloon missions (21 scheduled)
- Sounding rocket missions (22 scheduled)

OPERATIONAL

- Commercial cargo resupply missions for the Space station (2)
- Airborne Science missions, such as the Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS)
- Scientific balloons flights from New Zealand, Sweden, and New Mexico
- Sounding rockets flights from Norway, Alaska, Wallops, White Sands, and Australia
- Tracking and telemetry support for Artemis missions
- Commercial Crew Program airdrop deployment tests

ORBITAL SERVICING AND ASSEMBLY

nexis.gsfc.nasa.gov

Goddard is pioneering in-orbit servicing, assembly and manufacturing capabilities to enable exploration and science missions, from extending the life spans of satellites via refueling and repair, to assembling massive life-seeking telescopes in space, to upgrading and augmenting observatories via cooperative, modular interfaces.

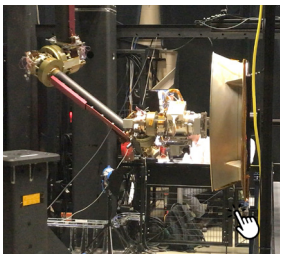
The center is collaborating with and transferring these technologies to civil, security and commercial stakeholders to usher in a new era of more sustainable, affordable and resilient spaceflight and jump-start new U.S. industries.

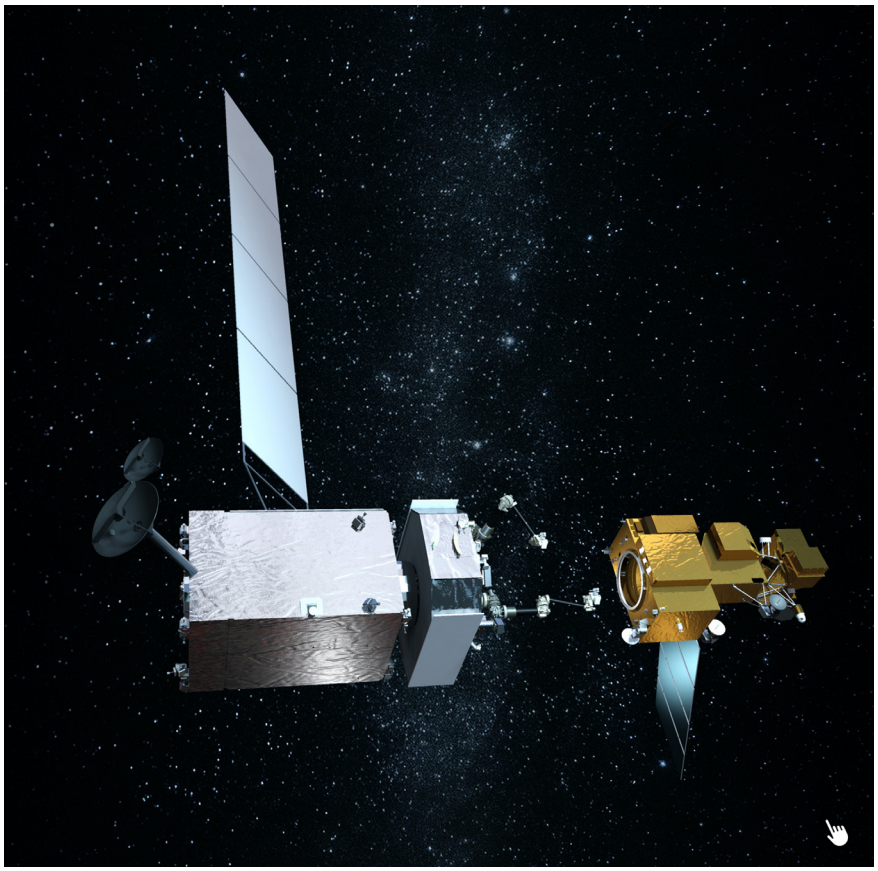
Cross-Cutting Technologies and Capabilities

Budget: $310.2M

Goddard Budget Percentage: 6.4%

- **Facility:**
  - **Greenbelt**





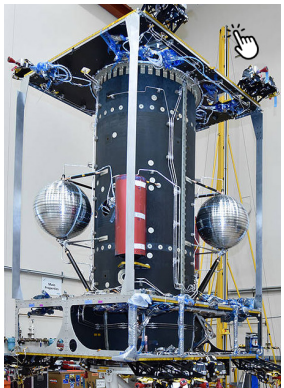
Missions & Instruments

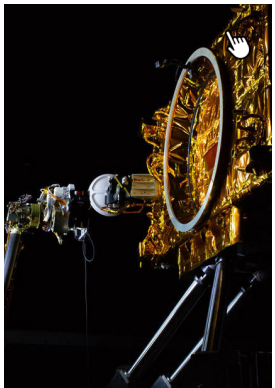
IN DEVELOPMENT

- On-orbit Servicing, Assembly, and Manufacturing 1 (OSAM-1) mission

OPERATIONAL

- Robotic External Leak Locator (RELL)
- Robotic Refueling Mission 3 (RRM3)
- Robotic Tool Stowage (RiTS)





WHY IT MATTERS

A PLACE FOR SERVICE

Our talented people, driven by passion toward a common and worthy purpose, have made possible countless improvements to our knowledge and way of life. We safeguard the long-term public trust by cultivating our workforce, ensuring a safe and sustainable workplace, effectively meeting our mission commitments, and applying our scientific breakthroughs to stimulate economic growth, foster education, inspire the nation, and impact the world. All of this is accomplished through a broad spectrum of institutional support efforts, including:

- Legal
- Procurement
- Information technology
- Financial management
- Human capital management
- Equal opportunity programs
- Diversity and inclusion
- Conflict management
- Protective services
- Logistics
- Environmental and medical management
- Facilities management and transportation
- Knowledge and information management
- Government and community relations
- Proposal development
- Education and public outreach
- Public communication

PUBLIC COMMUNICATION

**Click on an image to view original post.*

The commitment by the Goddard Office of Communications to public engagement and communications ensures that the public – our most important stakeholder – remains informed and engaged in our missions and projects. The visitor centers on the Greenbelt and Wallops campuses, tours, and public engagement events provide an opportunity to directly engage with our work.

Multimedia resources give external news organizations and others access to Goddard's activities and subject matters experts, further allowing us to communicate our work to the public. These include TV media outreach campaigns, such as those covering the launches of Lucy and the James Webb Space Telescope, as well as other significant events in 2021.

Since the advent of social media about 16 years ago, Goddard has been at the forefront of developing these platforms into a major component of NASA's communications efforts. Goddard-based teams operate or contribute to about 100 official NASA social media accounts. Goddard is a major leader for the agency's flagship social media accounts for science:

@NASAEarth
@NASASun
@NASAMoon
@NASASolarSystem
@NASAUniverse

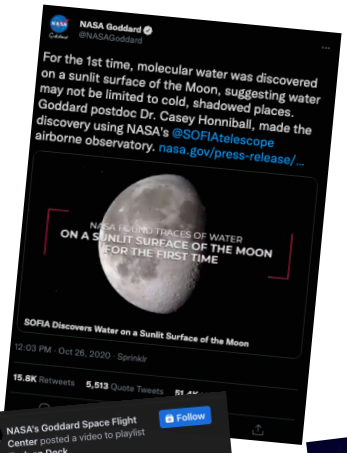
SOCIAL MEDIA FOLLOWERS

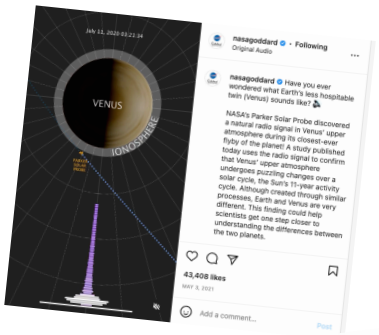
NASA GODDARD
1.3+ MILLION
2.5+ MILLION
777,000+
1+ MILLION

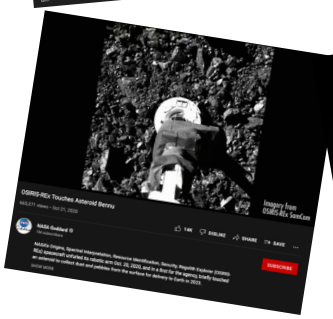
NASAEarth
10.7+ MILLION

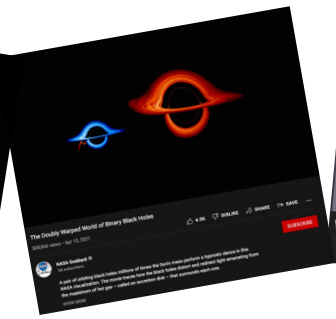
NASAHubble
7.3+ MILLION

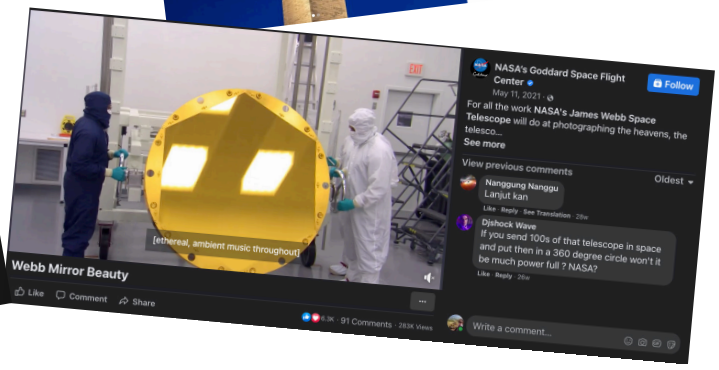
NASAWebb
1+ MILLION





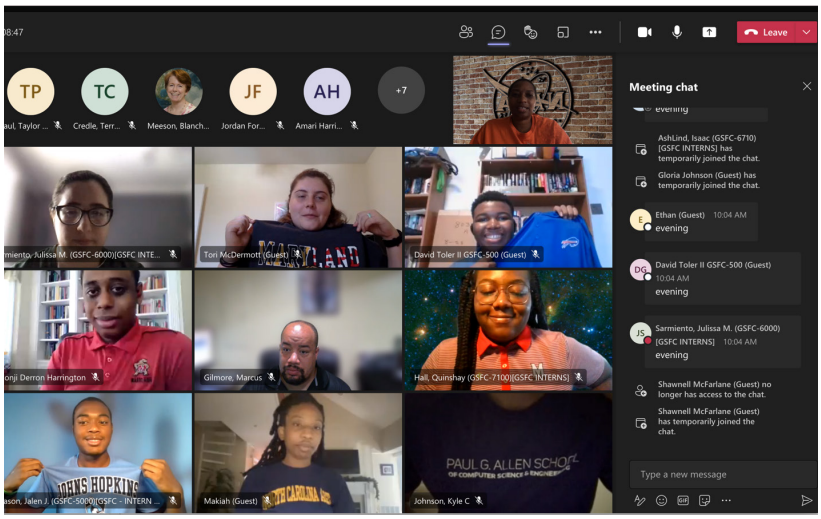




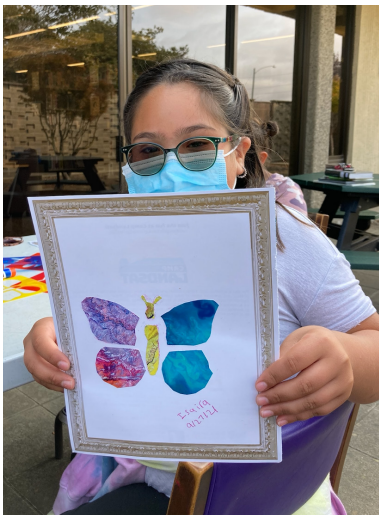


STEM ENGAGEMENT

The Goddard Office of STEM Engagement immerses students and educators at all levels of NASA's work, enhances STEM literacy and inspires the next generation to explore.



(ABOVE) STEM Pipeline for Equity, Inclusion and Diversity is a new Godard program helping build a diverse future STEM workforce that engages student cohorts in authentic, year-round learning experiences with NASA experts, projects, and facilities. It aims to provide a roadmap of experiences to inspire, engage, and educate the next generation of STEM leaders and address issues of the underrepresentation of minorities in STEM.



(ABOVE) Camp Landsat – a nine-week virtual summer camp – engaged the public around the Landsat 9 launch with curated story maps, online interactives, the Landsat Collage STEAM activity, and more.

(LEFT) Students monitor and pilot their drones during a REC Foundation Aerial Drones Competition qualifier in West Virginia. The event was one of several STEM competitions facilitated by the Katherine Johnson Independent Verification & Validation Facility Educator Resource Center.

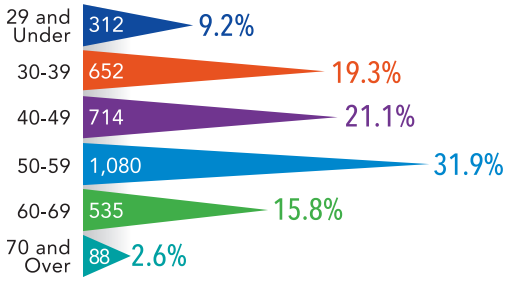
(ABOVE) Student flight opportunities – such as RockOn, RockSat-C, and RockSat-X – with the NASA Sounding Rocket Program at Wallops Flight Facility and the Colorado Space Grant engaged more than 300 participants from universities and colleges from across the United States and Puerto Rico.

(ABOVE) The NASA Heliophysics Education Activation Team, Aurorasaurus project, and the STEAM Innovation Lab worked with NASA's Magnetospheric Multiscale mission to design and create the world's first 3D-printed Magnetosphere Model. The model provides a way for participants to learn about 3D printing and Earth's magnetic field, which plays a crucial role in how the Sun interacts with Earth.

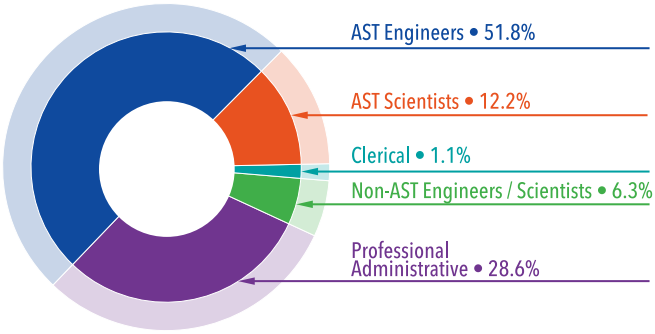
OUR PEOPLE

STATE OF THE WORKFORCE 2021

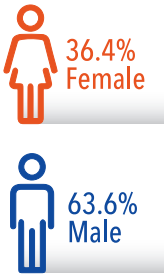
GODDARD CIVIL SERVANTS by Age Group



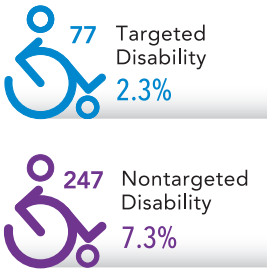
GODDARD CIVIL SERVANTS by Skill Mix



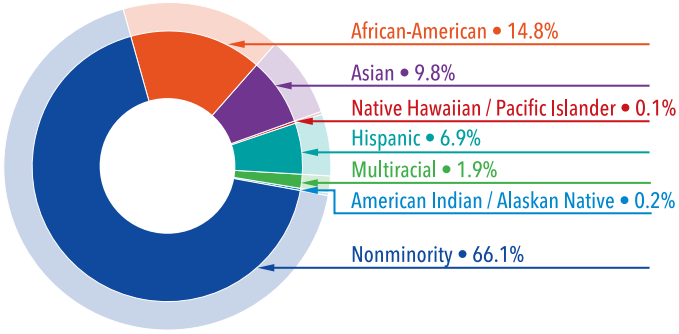
GODDARD CIVIL SERVANTS by Gender



GODDARD CIVIL SERVANTS by Disability



GODDARD CIVIL SERVANTS by Ethnicity



NASA's Goddard Space Flight strives to enable a culture of inclusion in which all employees feel welcome, respected, connected, and engaged in alignment with NASA's Unity Campaign and its latest core value of inclusion. Diversity, inclusion, and equal opportunity are vital to the center's mission, unlocking innovation, collaboration, and creativity along the path to mission success.

Ten advisory committees – representing and inclusive of employees from all backgrounds – provide benefits for both employees and the center, such as creating safe spaces to build connections, welcoming new employees and interns, promoting recruitment and retention efforts, enabling engagement, and fostering an inclusive work environment.

Goddard Program Year 2021 Budget

CATEGORIZED BY LINES OF BUSINESS (AS OF SEPT. 30, 2021)

BUDGET: $4.8B

DIRECT GODDARD BUDGET: $4.0B

REIMBURSABLE GODDARD BUDGET: $800M

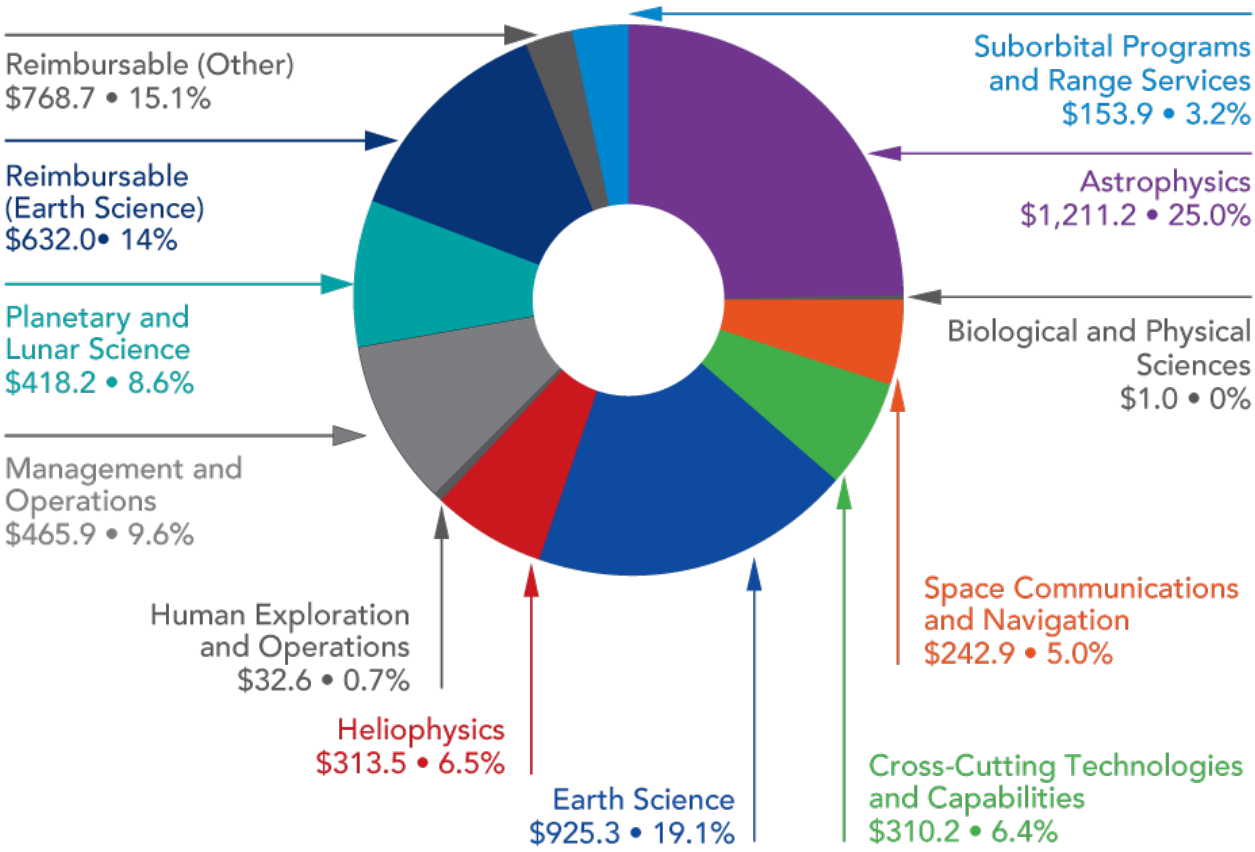


CHART IS IN $Ms

ECONOMIC IMPACT

Goddard's success in enabling NASA missions and applying these scientific achievements to society is evident. Each of Goddard's six locations supports the center's ability to stimulate and strengthen economic activity by:

- Expending goods and services to perform its mission.
- Generating technology transfer and spinoff activities.
- Broadening small business opportunities through its robust contracting program.

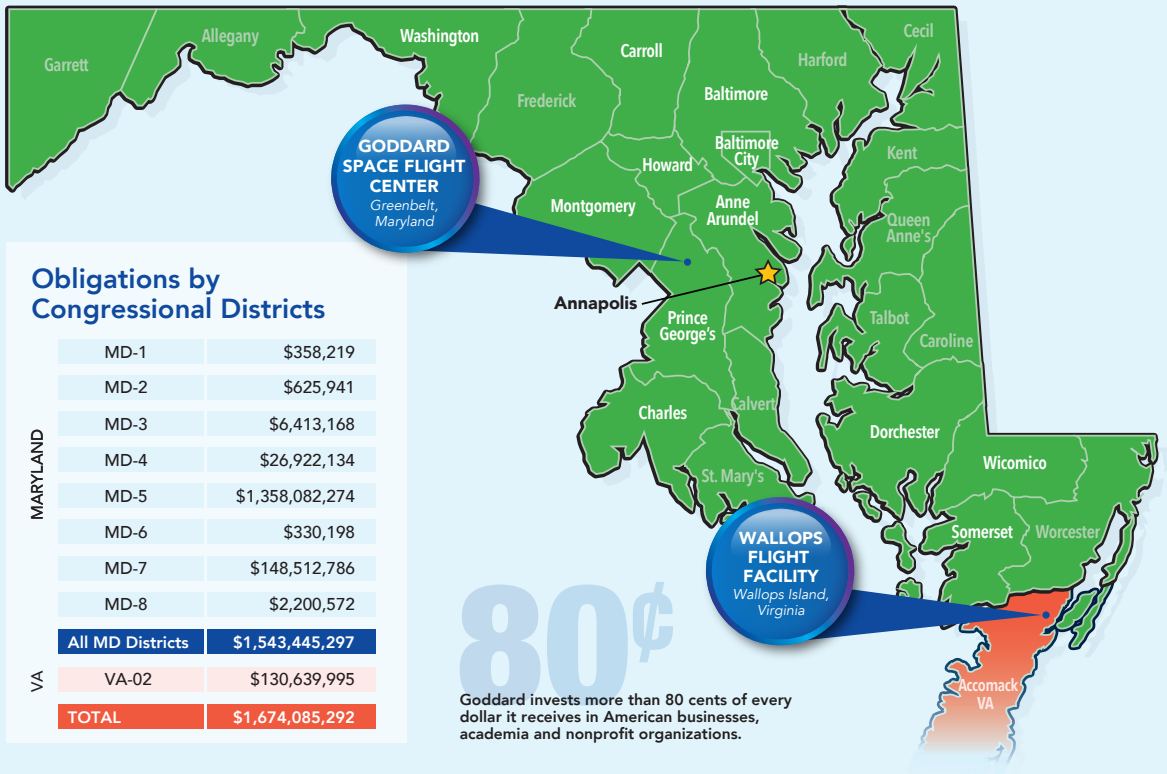
Obligations by State

District of Columbia	$13,914,143
Delaware	$1,012,450
Maryland	$1,543,445,296
New Jersey	$14,613,431
New York	$99,643,366
Pennsylvania	$9,310,745
Virginia	$363,869,094
West Virginia	$47,457,468

Obligations by Maryland County

Anne Arundel	$568,397	Howard	$10,977,563
Baltimore	$7,749,825	Montgomery	$2,535,633
Baltimore City	$136,359,992	Prince George's	$1,384,879,068
Carroll	$293,690	Somerset	$27,500
Charles	$461	Washington	$21,219
Dorchester	-$51	Wicomico	$32,000

Total $1,543,445,296



Obligations by Congressional Districts

MARYLAND

MD-1	$358,219
MD-2	$625,941
MD-3	$6,413,168
MD-4	$26,922,134
MD-5	$1,358,082,274
MD-6	$330,198
MD-7	$148,512,786
MD-8	$2,200,572
All MD Districts	$1,543,445,297

VA

VA-02	$130,639,995
TOTAL	$1,674,085,292

80¢

Goddard invests more than 80 cents of every dollar it receives in American businesses, academia and nonprofit organizations.

Goddard's Top Contractors

1.	Orbital Sciences Corporation	$280.3 M
2.	Northrop Grumman Systems Corporation	$224.9 M
3.	Science Systems and Applications, Inc.	$216.0 M
4.	Peraton Inc.	$201.0 M
5.	Science Applications International Corporation	$181.5 M
6.	Ball Aerospace & Technologies Corporation	$176.1 M
7.	KBRwyle Technology Solutions, LLC	$147.2M
8.	ATA Aerospace, LLC	$129.9 M
9.	Lockheed Martin Corporation	$125.4 M
10.	Southwest Research Institute	$120.8 M

All numbers are based on NASA Procurement Data View and Federal Procurement Data System obligation data for fiscal 2021 as of Oct. 13, 2021. Obligated funds, both Goddard and NASA Shared Services Center.

IN MEMORIAM

As we celebrate our collective achievements, we also honor all of those who have contributed to Goddard and are no longer with us.

Your dedication and talent will never be forgotten.

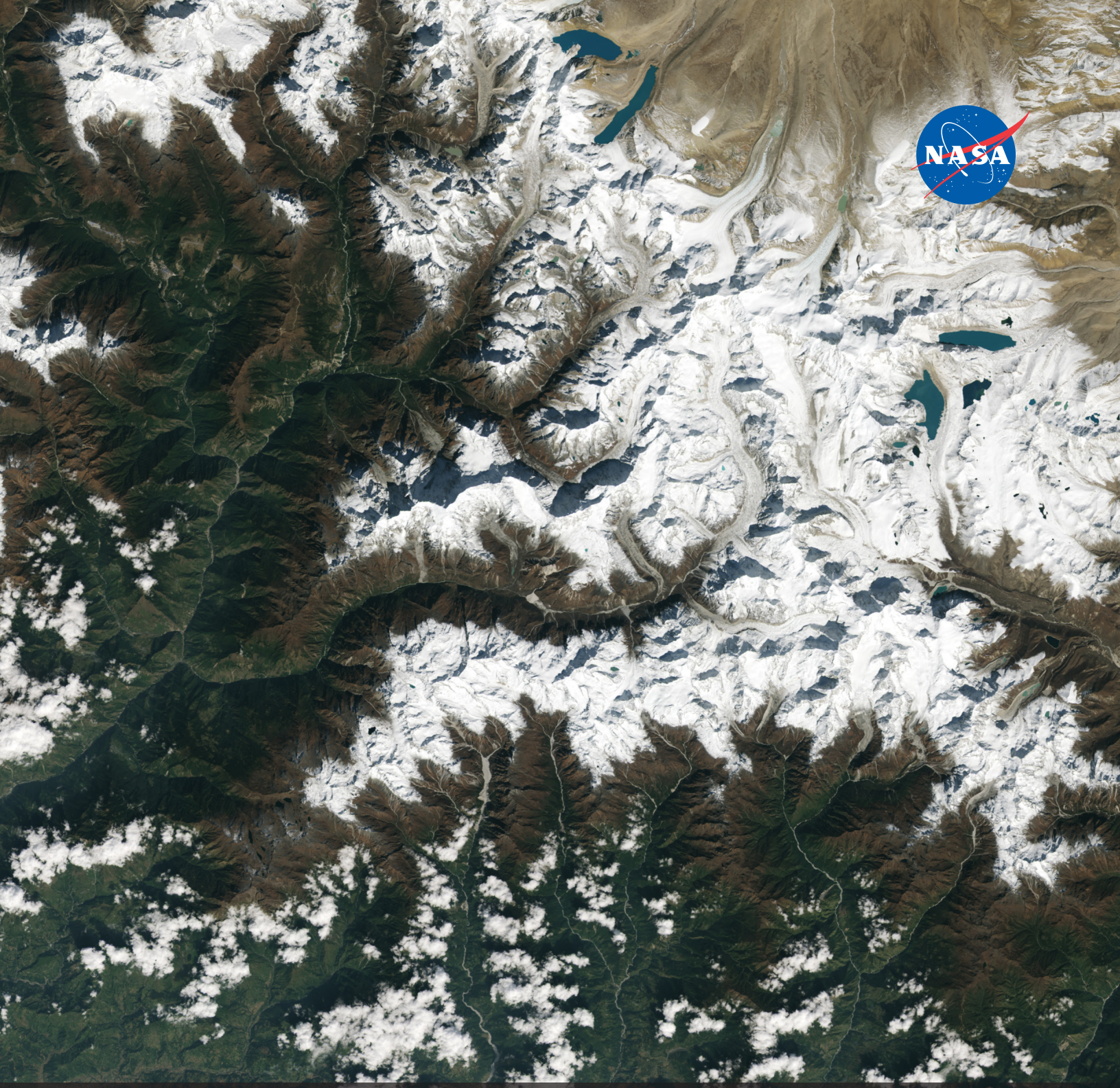
Active civil servants who passed away from October 2020 through September 2021 include:

THOMAS J. GRIFFIN
DAVID L. JACINTHO
RONALD JAMES OLIVERSEN
FRANK J. STOCKLIN
KATHLEEN M. TENNANT
ELISSA HEATHER WILLIAMS

‡Contractors, former civil servants and others whose reported passing occurred from October 2020 through September 2021 include:

DONALD GLENN ANNA
ROBERT ARVEY
GILBERT P. BECKLIN
RICHARD ALAN BREWER
PETER T. BURR SR.
JON BUSSE
JOHN PATRICK CALLAN SR.
ABBAS CONTRACTOR
LORENZO ROSS COVINGTON
CORNELIS DE KRAMER
RICHARD ANTHONY DEMARCO
RICHARD J. DRACHMAN
SAJJAD H. DURRANI
ROBERT EDWARD DWYER
FRANCO EINAUDI
JAMES LIVINGSTON FARIS
THOMAS J. GRENCHIK
PAULA THEODORA BENEDYK GROVES
RONALD RICHEY GUNTON
JAMES P. HEPPNER
LARRY SYLVESTER JEFFERSON
RICHARD SINCLAIR KING
GEORGE C. KRONMILLER JR.
PAUL LANG
JOHN LANGMEAD
JOHN DAVID LAWS
CHARLES M. MACKENZIE
RAYMOND W. MELCHER
J. STEVE METCALF
HENRY JAMES MIDDLETON
HARRY E. MONTGOMERY
BERNARD GILBERT NARROW
DAVID DEAN NEILL
JOHN S. NISBET
SYLVIA NADINE HOLLAND PARKER
ANTHONY J. PIERRO SR.
GUIDO PORRECA
CHARLES A. RICHEY
MALCOLM PAUL SAVEDOFF
ALFRED H. M. SHEHAB
GAIL SKOFRONICK-JACKSON
GREGORY FRANKLIN SMITH
ROBERT CLINTON SUTPHIN
ROBERT WIGAND
HAROLD WILLIAM WOOD

‡NASA does not have access to this information for former civil servants, contractors, and other affiliated with Goddard. The report authors have been informally notified of some individuals. An earnest attempt was made to collect this information. However, the nature of the process could result in an incomplete list.



Goddard
SPACE FLIGHT CENTER

For more information, please visit our website:
www.nasa.gov/goddard

www.nasa.gov

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