National Aeronautics and Space Administration

2019 ANNUAL REPORT

GODDARD SPACE FLIGHT CENTER

Bringing the Universe Into View Since 1959

60

www.nasa.gov

THE GODDARD PROJECT LIFE CYCLE

This icon indicates expanded video content. An interactive version of this report is also posted on Issuu.com.

TABLE OF CONTENTS

World-Class Organization

SIX UNIQUE SITES

OVER 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.

A MESSAGE FROM THE DIRECTOR

For the past 60 years, NASA's Goddard Space Flight Center has taken on some of the most compelling questions about the nature of our universe and provided critical information about the weather, climate and environment here on Earth. In six decades, our work has yielded countless achievements and discoveries that have moved humanity forward.

Since our beginnings in 1959, we have supported NASA's efforts in human spaceflight, from the Mercury and Gemini programs and Apollo lunar landings to today's International Space Station expeditions and tomorrow's Artemis program. With the world's largest concentration of scientists and engineers dedicated to the study of Earth and space, Goddard has produced hundreds of groundbreaking missions. We have modeled Earth's ongoing changes; worked on characterizing the Sun, moons and planets comprising our solar system; and begun to explain how the first stars and galaxies may have evolved over billions of years.

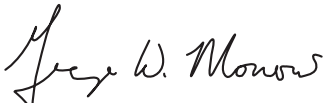
This year, Goddard's body of work continued to build upon our legacy of success. Aligned with national priorities, our highlights include the OSIRIS-REx asteroid sample return mission, which reached its target site; the TESS satellite that returned data on dozens of planets outside our solar system that may be capable of supporting life; and the recently launched ICESat-2 Earth-observing sentinel, which has collected over a trillion measurements of our planet's ice and forests.

We also made significant progress on flagship missions of the future. Select components of the James Webb Space Telescope—which will be the most powerful space telescope ever built—were integrated together for the first time as testing continues toward launch in 2021. Furthermore, Goddard will play a leading role in the agency's next solar system mission, Dragonfly, which is designed to explore the prebiotic organic chemistry of Saturn's largest moon, Titan.

By 2024, NASA is chartered to send the next man and first woman to the surface of the Moon—the start of a sustained presence—before eventually setting off to Mars. As these visionary projects are developed, the center's expertise will be critical. Goddard's Lunar Reconnaissance Orbiter has been providing vital data about the Moon's surface for the past decade, while the Sample Analysis at Mars instrument suite aboard the Mars Curiosity rover and the Mars Atmosphere and Volatile Evolution mission have been examining the surface and atmospheric conditions of the Red Planet.

I invite you to read the report that follows, which highlights our accomplishments over the past year and more. It also provides a general blueprint for where we are headed. The nature of exploration itself means there is always more to achieve and more truths to discover.

As we look back at the last 60 years and accept the challenges of the decades ahead, we use our past as precedent, knowing there is no limit to what we can accomplish in the universe.



George W. Morrow
Center Director (Acting)

SIXTY YEARS OF TURNING DREAMS AND HOPES

INTO REALITY

When then-President Dwight D. Eisenhower signed the executive order that established NASA in 1958, leaders soon realized the need for a new facility to house the nation's brightest space scientists and engineers now part of the fledgling agency. Thus began our history as NASA's Goddard Space Flight Center on May 1, 1959.

Space exploration was still in its infancy, but NASA came to rely on its first spaceflight center to expand and enhance its capabilities. Project Mercury—the nation's first human spaceflight program—commenced less than a year before we began operations, and NASA called on Goddard to provide the program's computing center for its communications network. We would go on to develop and operate the communications networks for Project Gemini and for the Apollo Moon landings while also pioneering robotic scientific spacecraft, further demonstrating our indispensability to NASA's early ambitions.

Although the trajectory of exploration has changed considerably since those early days, Goddard is more critical than ever to NASA's mission.

As the focus on space science has developed alongside human spaceflight efforts, Goddard has been leading the way in bringing the universe into view. Our modest beginnings with programs such as Project Vanguard have evolved to encompass more than 300 missions and 800 patents—as well as a Nobel Prize. We are NASA's preeminent science center, executing the agency's most complex science missions, enabling transformational research, and improving lives daily through the exploration of Earth and space.

Our engineering and project management leadership bolsters our unique ability to conceive, build, integrate, test, launch and operate spacecraft and science instruments of all sizes and to all destinations. Our partnerships with other federal agencies, industry and academia; our efforts to inspire the next generation of explorers; and the application of our innovative technologies and scientific research all have profound impacts on society and move Earth and space exploration forward.

As our namesake, rocketry pioneer Robert H. Goddard, famously said, "It is difficult to say what is impossible, for the dream of yesterday is the hope of today and the reality of tomorrow." No place exemplifies his words better than the NASA center that bears his name.

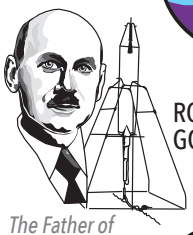
Six Locations Nationwide

Plus many other locations worldwide

GODDARD Greenbelt Campus
Maryland

GODDARD INSTITUTE FOR SPACE STUDIES
New York, New York

WHITE SANDS COMPLEX
Las Cruces, New Mexico



ROBERT H. GODDARD
The Father of Modern Rocketry

WALLOPS FLIGHT FACILITY
Wallops Island, Virginia

KATHERINE JOHNSON INDEPENDENT VERIFICATION & VALIDATION FACILITY
Fairmont, West Virginia

COLUMBIA SCIENTIFIC BALLOON FACILITY
Palestine, Texas

*Goddard-managed ground communications stations
^Goddard-assumed management

Over six decades, Goddard has grown from 1,200 acres in Greenbelt, Maryland, to an organization comprising five additional sites across the country. Our collective capabilities today include the talented workforces of Wallops Flight Facility, Goddard Institute for Space Studies, Katherine Johnson Independent Verification & Validation Facility, White Sands Complex, and Columbia Scientific Balloon Facility.

2019 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: $4.9B

Direct GSFC Budget: $3.9B

Reimbursable GSFC Budget: $1.0B

(From other government and nongovernment entities)

Joint Agency Satellites

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 (2018 Rankings)

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

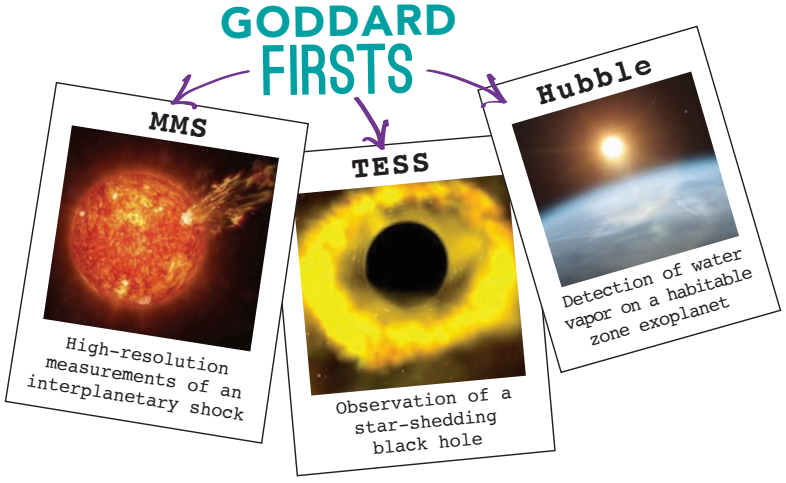
#16 GODDARD RANKED OUT OF 415 AGENCY SUBCOMPONENT ORGANIZATIONS
(Second-Highest Among NASA Centers)

ICESat-2

315 BILLION LASER SHOTS FIRED

ICE, CLOUD, AND LAND ELEVATION SATELLITE — ICESat — NASA Goddard Space Flight Center

GODDARD FIRSTS



TESS

TRANSITING EXOPLANET SURVEY SATELLITE

32 EXOPLANETS DISCOVERED

WALLOPS FLIGHT FACILITY

116,000+ launches since 1945

1,000+ AIRCRAFT FLIGHT HOURS

20 SOUNDING ROCKET LAUNCHES

17 BALLOON MISSIONS

2 ISS RESUPPLY MISSIONS SUPPORTED

Goddard Visitor Center

3 NEW EXHIBITS

41,113 TOTAL VISITORS

COLUMBIA SCIENTIFIC BALLOON FACILITY

1,700+

BALLOONS LAUNCHED SINCE 1961 FOR:

35 Universities

23 Research Agencies

33 Foreign Groups

KATHERINE JOHNSON IV&V FACILITY

15 NASA MISSIONS SUPPORTED

46 SEVERITY-ONE ISSUES IDENTIFIED

508 articles posted to NASA.gov

126 videos uploaded to YouTube

OSIRIS-REx ASTEROID SAMPLE RETURN MISSION

2 Guinness World Records

Closest orbit of a planetary body

Smallest object ever orbited

75 COUNTRIES PARTICIPATED IN INTERNATIONAL OBSERVE THE MOON NIGHT, LED BY GODDARD ON BEHALF OF NASA

40 High school students attend STEM **Girls** Night In event

50 High school students attend **first** STEM **Boys** Night In event

TWO TEAMS

selected to analyze unopened Apollo samples

Figures are for fiscal 2019 unless noted otherwise.

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.

Our Focus Areas

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 assures outcomes for missions and their supporting elements and services.

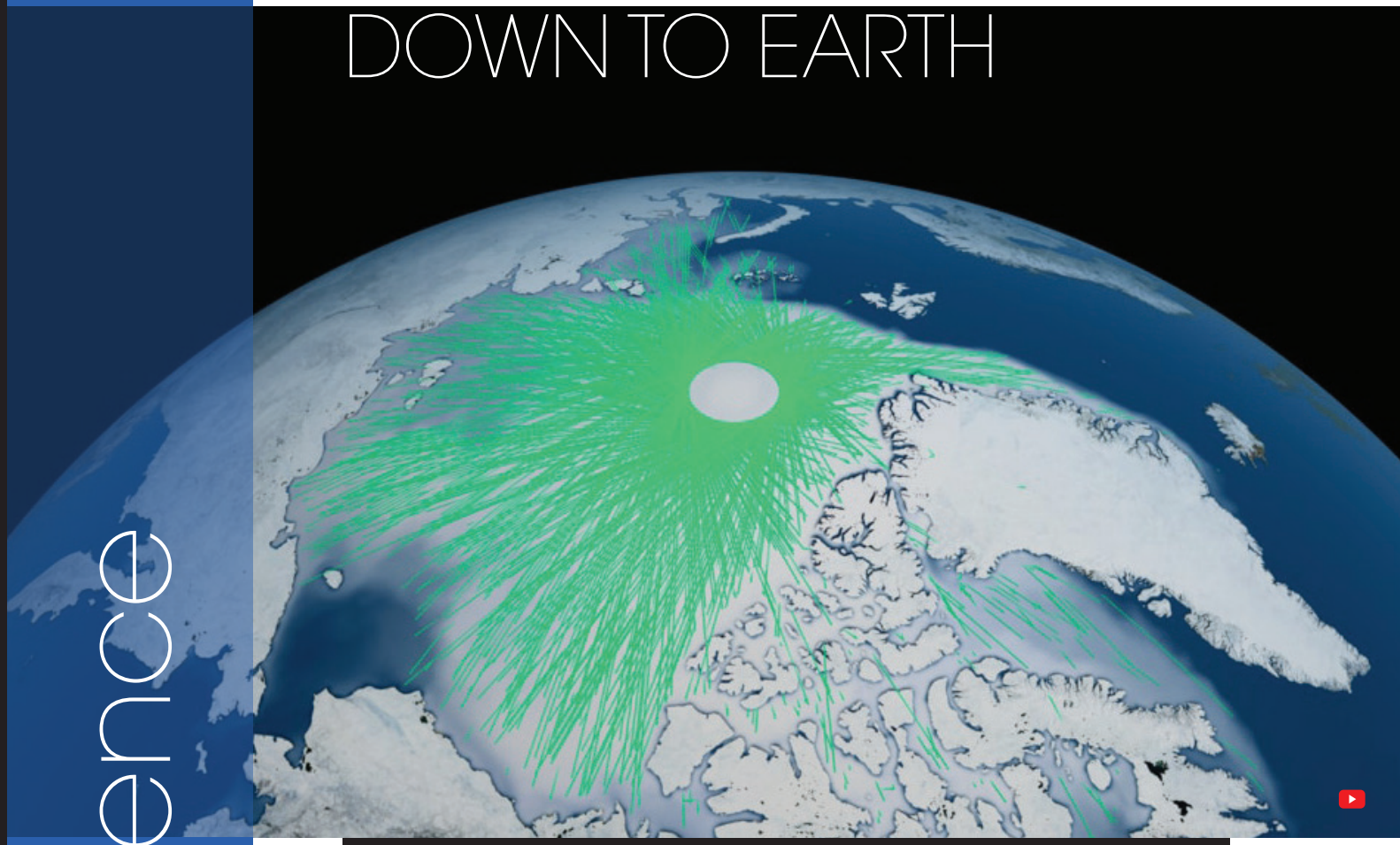
End-to-End Mission Systems Architecture and Engineering

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.

BRINGING NASA DOWN TO EARTH



HELPING HUMANKIND

Goddard employs expert teams of scientists and engineers to manage its complex missions. Many of these missions have revolutionized our fundamental understanding of how our own planet functions as an interconnected system. People continue to find ways of applying NASA's view of Earth to everyday life.

Applied science activities link researchers across the Goddard Earth Sciences Division with end users and foster interagency collaborations and external partnerships. Such collaborations produce practical and innovative uses for Earth observations to benefit society, such as crop yield forecasts and other decision-support tools.

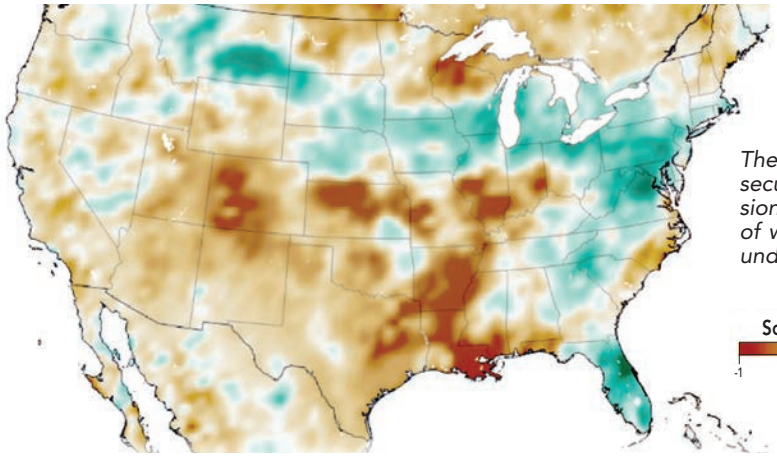
In addition, NASA has a long history of transferring technology to the private sector. "Spinoffs" are commercial products and services derived from NASA technology or improved through NASA partnerships. These technologies—developed for the study of space and Earth—have generated billions of dollars in both revenue and saved costs combined, created tens of thousands of jobs, and improved quality of living across the United States and around the world.

A joint campaign led by NASA and the National Oceanic and Atmospheric Administration, Fire Influence on Regional to Global Environments and Air Quality, FIREX-AQ, is targeting broad questions about the chemical and physical properties of smoke from fire, how it is measured and how it changes from the moment of combustion to its final dissipation hundreds or thousands of miles downwind. All of these have implications for public health.

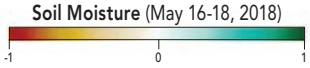
Since 2016, Oscar trophies have been plated in gold using a technique that was improved in part for the Mars Orbiter Laser Altimeter. The same plating was used for the cooling tube on the interior of the James Webb Space Telescope because of its reflective and tarnish-proof properties.

Using data from Landsat 8, a collaboration between Goddard and the U.S. Geological Survey, first responders were able to better track water levels and evacuate residents during floods in the Midwest in March 2019.

Compact spectrometers, such as the one pictured, are unveiling clues to diagnose cancer. They were developed from a similar device used in the 1990s to detect planets outside of our solar system.



The availability of water plays a vital role in food security. Goddard satellites inform agricultural decisions by monitoring changes in the volume and flow of water in Earth's atmosphere, land surfaces and underground aquifers.



MOON TO MARS EFFORT

OUR CONTRIBUTIONS

Space Communications: A mission to the Moon would be impossible without the communications networks managed and operated by Goddard. These networks provide data return, tracking, telemetry and command to missions, from launch all the way to lunar orbit. Goddard is also developing next-generation technology to allow astronauts to connect with Earth faster than ever before, beginning with the Artemis II mission. (See diagram on page 13.)

Orbital Servicing and Assembly: Through satellite servicing missions, Goddard is developing and demonstrating technology for servicing spacecraft, as well as performing manufacturing and assembly, in orbit. These capabilities are a necessity for building and maintaining NASA's lunar outpost, the Gateway.

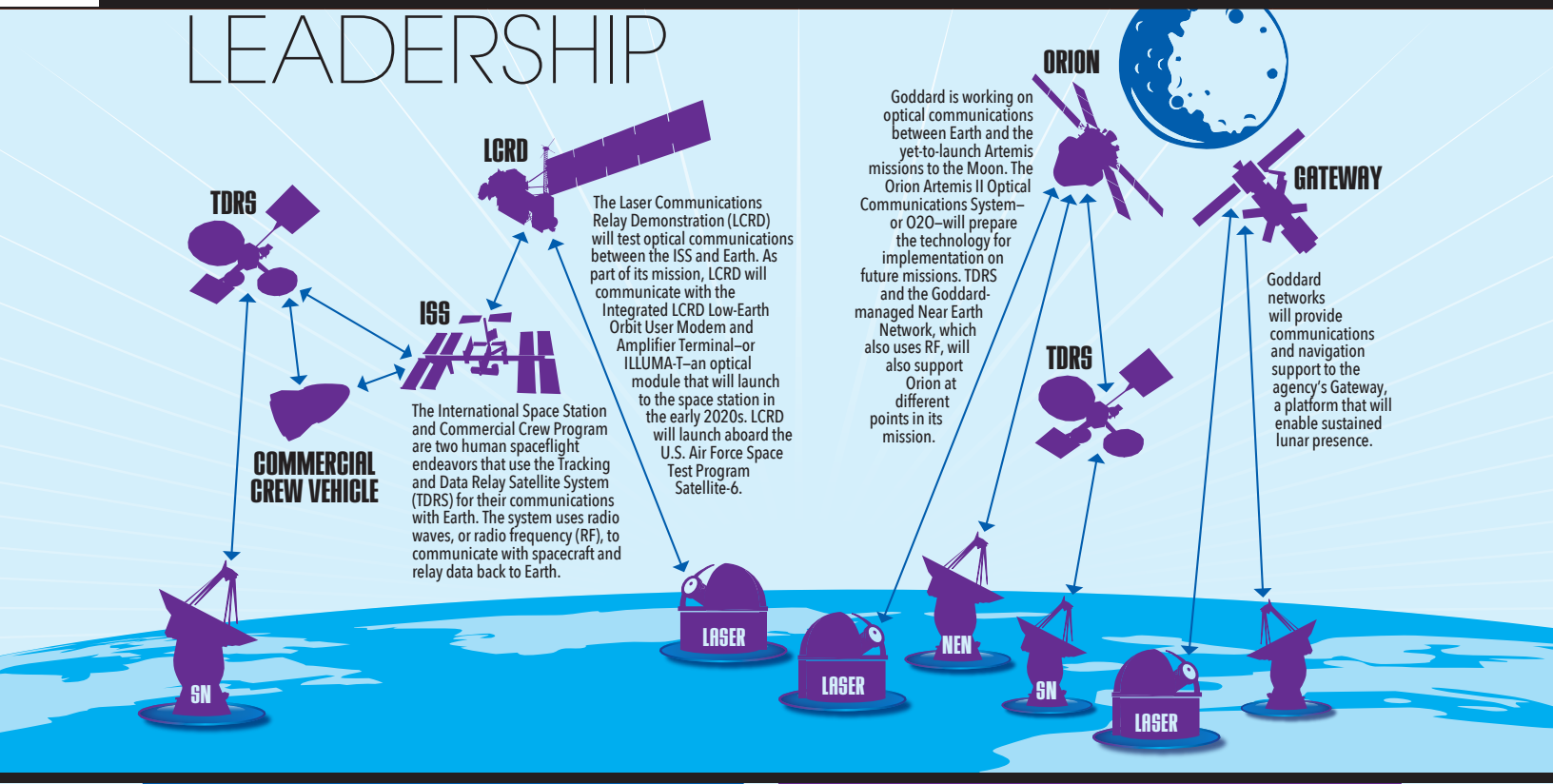
Instrument and Spacecraft Development: Goddard has a storied legacy of developing reliable instruments and spacecraft for robotic missions. The center applies this expertise and catalog of existing technology to instrument development for exploration missions.

Interplanetary Navigation: Goddard astrophysicists today are developing the ability to navigate accurately in deep space using pulsars, similar to how GPS enables navigation on Earth.

Space Weather and Radiation: Goddard's solar science missions provide detailed data about space weather and solar radiation. What we learn helps scientists understand how to keep astronauts, instruments and spacecraft safe from the devastating effects of the Sun and the space environment.

Planetary Environments: Discoveries like those enabled by the Lunar Reconnaissance Orbiter's high-resolution, topographical maps of the Moon will help determine a safe landing location on the Moon, while our Earth scientists' environmental expertise will give astronauts knowledge they need about the water, atmosphere and geology at their destinations.

COMMUNICATIONS LEADERSHIP



HOW WE DO IT

Space Network (SN)

SN is a constellation of 10 Earth-orbiting Tracking and Data Relay Satellites and four ground terminal locations that collectively provide a continuous global link between spacecraft and the ground.

Near Earth Network (NEN)

NEN is a series of more than 15 globally located NASA-owned and contracted commercial ground terminals that provides comprehensive communications services to satellites from near-Earth orbit to a million miles from Earth.

NASA Communications Network (NASCOM)

NASCOM is the central nervous system connected to all of NASA's communications circuits. NASCOM transports and delivers data to control centers and data centers, which process and disseminate the data for the scientific community, other agencies and the public.

Optical Communications

As the center of excellence for optical communications, Goddard is implementing next-generation communications infrastructure that uses infrared waves to deliver more data at a time—while using smaller, lighter and more power-efficient systems.

BENEFITS OF NEW TECHNOLOGY

Better Data Rates

Goddard is working on implementing several new communications technologies that will deliver more data at a time to Earth. NEN is constructing new antennas that can communicate via Ka-band to support the higher data requirements of new science missions. Optical communications also transmit more data at a time through its higher infrared electromagnetic frequency.

Size, Weight and Power Efficiencies

Optical communications can enable better data rates, and its systems can be much smaller than current RF systems. Optical telescopes on the ground can be as small as a few inches, while RF antennas are at least several meters in diameter.

Technology Transfer

NASA-developed technologies are often transferred to the private sector for the public's benefit. One of NASA's goals is to transfer space communications technologies to the private sector, including the technology for optical communications payloads and ground stations.

Industry Partnerships

Working with industry provides economic benefits to NASA and helps infuse emerging commercial technologies into the agency's space communications capabilities. These collaborations also create jobs within industry.

HONORING THE BEST

KATHERINE JOHNSON INDEPENDENT VERIFICATION & VALIDATION FACILITY

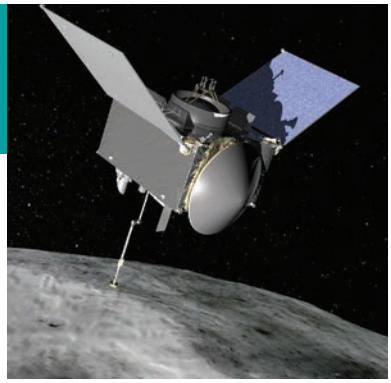
Since its inception more than a quarter-century ago, the Independent Verification & Validation Facility in Fairmont, West Virginia, has provided software safety and assurance services for some of NASA's most important missions, including the Space Shuttle Program, International Space Station and now the Artemis lunar exploration program.

On July 2, 2019, the facility was renamed in honor of NASA mathematician and West Virginia native Katherine Johnson, who played key roles during some of the agency's early human spaceflight endeavors. Her story, along with those of fellow mathematicians Mary Jackson and Dorothy Vaughan, was documented in the 2016 film "Hidden Figures."

HIGHLIGHTS OF FISCAL 2019

OSIRIS-REx

PLANETARY



The Origins, Spectral Interpretation, Resource Identification, and Security-Regolith Explorer (OSIRIS-REx) launched in 2016 to return a sample from the near-Earth asteroid Bennu by 2023. The mission reached its target in December 2018 and has identified potential sites for sample acquisition. Upon the arrival of OSIRIS-REx, Bennu became the smallest celestial body ever orbited by a spacecraft. OSIRIS-REx also set a record for the closest orbit of a planetary body by a spacecraft.

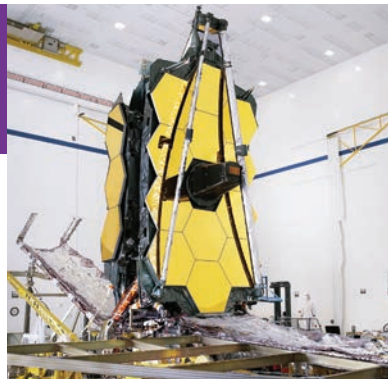
ICESat-2

EARTH

Less than a year after its launch in September 2018, the Ice, Cloud and land Elevation Satellite-2 (ICESat-2)—with the Goddard-developed Advanced Topographic Laser Altimeter System, or ATLAS, aboard—collected more than a trillion new measurements on Earth's glaciers, sea ice, forests and more, allowing scientists to track the slightest changes in our planet's polar regions. ICESat-2 has far surpassed the 2 billion measurements taken by its predecessor, ICESat, which operated from 2003 through 2009.

Webb

ASTRO



The James Webb Space Telescope—an international project led by NASA with its partners, ESA (European Space Agency) and the Canadian Space Agency—will observe the formation of the first stars and galaxies and help discover how they have evolved over billions of years. In August 2019, all elements of the telescope were assembled for the first time at a Northrop Grumman facility in California. It will be the most powerful space telescope ever built upon its completion and launch in 2021.

Wallops Launches

SUBORBITAL

NASA's Wallops Flight Facility launched a significantly larger number of suborbital missions in fiscal 2019 compared to past years. These included 20 sounding rockets, 17 high-altitude balloons and about 1,000 aircraft flight hours. Three scientific balloons were launched from Antarctica, with one super-pressure balloon setting a pathfinder flight record of 76 days. Wallops also managed 30 CubeSat missions and launched two resupply missions to the International Space Station, one of which included a payload for the orbiting laboratory.

HIGHLIGHTS OF FISCAL 2019

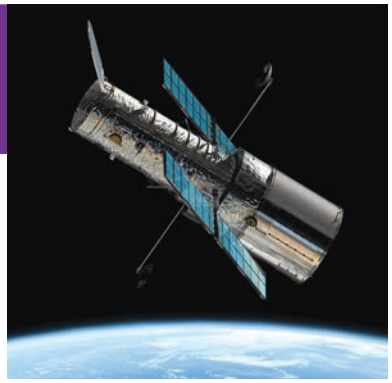
SET
HELIO

NASA's Space Environment Testbeds (SET) mission, which launched in June 2019, studies how energetic particles from the Sun or deep space can affect spacecraft over time, providing valuable information on how to better protect spacecraft and improve their design, engineering and operations. The mission is equipped with a space weather monitor and Goddard-built experiments to characterize such effects. SET is part of the Goddard-managed Living With a Star program, which explores aspects of the Sun-Earth system that directly affect life and society.

PACE
EARTH

The Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission will measure the distribution of phytoplankton and other organisms that sustain the marine food web and augment existing measurements of key atmospheric variables associated with air quality and Earth's climate. The mission—whose spacecraft bus and primary instrument, the Ocean Color Instrument, will be built at Goddard—was approved to begin the implementation phase of its life cycle. The PACE team is moving ahead with its proposed plan in preparation for a 2022 launch.

Hubble
ASTRO



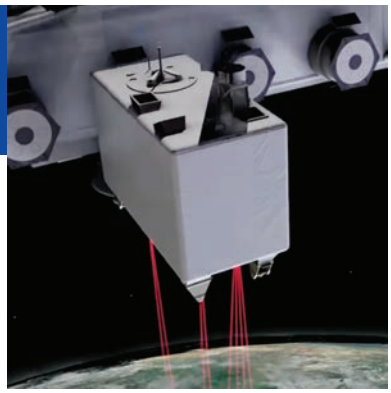
The Hubble Space Telescope continues its legacy as the most productive scientific mission in NASA's history, still providing discoveries 29 years after launch. In September 2019, Hubble detected water vapor for the first time on an exoplanet in a habitable zone—the region around a star in which liquid water could potentially pool on the surface of a rocky planet. Earlier in December 2018, Hubble celebrated the 25th anniversary of the first its five servicing missions, which collectively extended and enhanced the telescope's scientific capabilities.

Dragonfly
PLANETARY

NASA selected Dragonfly as the fourth addition to its New Frontiers program—a series of space exploration missions designed to research bodies in the solar system. A rover-size, dronelike vehicle, Dragonfly will explore the prebiotic organic chemistry of Titan—Saturn's largest moon. Scheduled to launch in 2026, the mission includes several partners. Goddard will build the Dragonfly Mass Spectrometer, a key instrument that will analyze samples collected from the surface.

GEDI

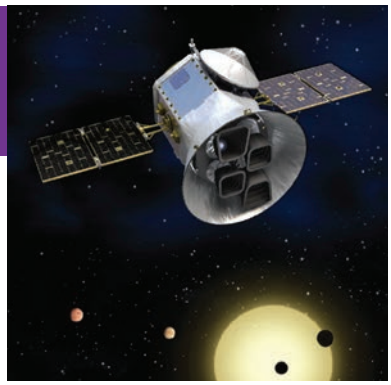
EARTH



Launched in December 2018, the Goddard-developed Global Ecosystem Dynamics Investigation Lidar (GEDI) is helping scientists create the first 3D map of the world's temperate and tropical forests. From its vantage point aboard the International Space Station, GEDI is collecting information on forests worldwide, including their height, the density of their branches, and the vertical and horizontal distribution of their foliage. The collective data provide insights into Earth's carbon cycle by fostering a better understanding of how forests store carbon.

TESS

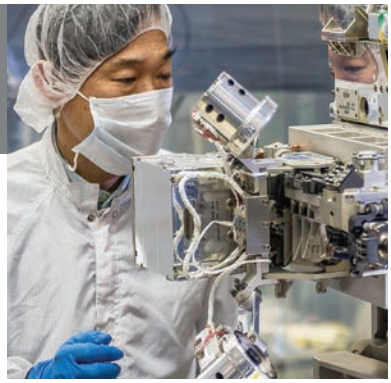
ASTRO



Launched in April 2018, the Transiting Exoplanet Survey Satellite (TESS) is searching for planets outside our solar system-known as exoplanets—some of which may even be capable of supporting life. The mission completed one year of surveying the southern sky in July 2019, discovering more than two dozen such exoplanets. TESS has also identified more than 1,000 candidate exoplanets that are awaiting confirmation from ground-based telescopes. It has now turned its attention to the northern sky to continue the most comprehensive planet-hunting expedition to date.

RRM3

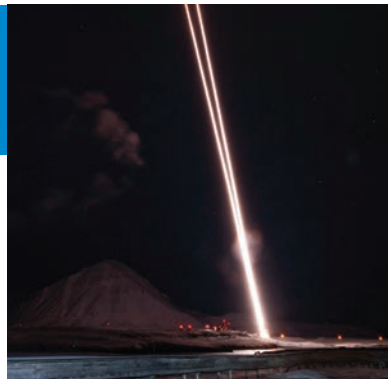
TECHNOLOGY



The Robotic Refueling Mission 3 (RRM3), launched in December 2018, is developing tools and techniques for storing and replenishing cryogenic spacecraft fuel. The ability to resupply cryogens in space could minimize the amount of fuel that spacecraft are required to carry from Earth, enabling them to travel farther and operate longer. RRM3 builds on previous phases, which practiced preparatory operations for robotically refueling spacecraft. It has accomplished several objectives, including the longest-ever in-space storage of cryogenic fluid with zero loss—four months.

VISIONS-2

SUBORBITAL



The Visualizing Ion Outflow via Neutral Atom Sensing-2 (VISIONS-2) rockets launched from Norway in December 2018 to study atmospheric escape, the process by which Earth's atmosphere slowly leaks into space. Understanding this process may provide insight into determining the habitability potential of other planets or how the Martian landscape became exposed and desolate. VISIONS-2 is supported through the NASA Sounding Rocket Program, which is managed by the NASA Heliophysics Division, at NASA's Wallops Flight Facility.

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

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.

MISSIONS IN DEVELOPMENT

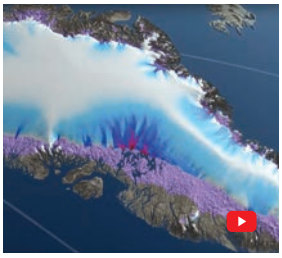
- Joint Polar Satellite System-2 (JPSS-2)*
- Landsat 9*
- Plankton, Aerosol, Cloud, ocean Ecosystem (PACE)

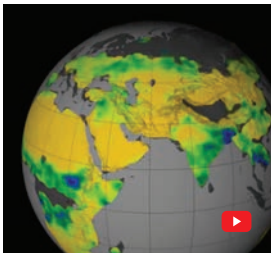
OPERATIONAL MISSIONS

- Aqua
- Aura
- Deep Space Climate Observatory (DSCOVR)*
- Global Ecosystem Dynamics Investigation (GEDI)
- Global Precipitation Measurement (GPM)*
- GOES-13*, GOES-14*, GOES-15*, GOES-16*, GOES-17*
- Ice, Cloud, and land Elevation Satellite-2 (ICESat-2)
- Joint Polar Satellite System-1 (JPSS-1/NOAA-20)
- Landsat 7*, Landsat 8*
- MetOp-C*
- NOAA-20*
- Soil Moisture Active Passive (SMAP) Radiometer
- Solar Radiation and Climate Experiment (SORCE)
- Suomi-National Polar-orbiting Partnership (Suomi-NPP)*
- Terra
- Total and Spectral Solar Irradiance Sensor (TSIS-1)

*Joint Agency Satellite

https://science.gsfc.nasa.gov/earth/

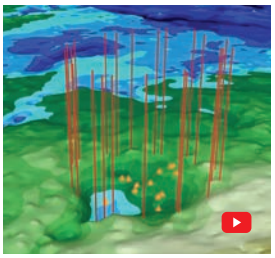


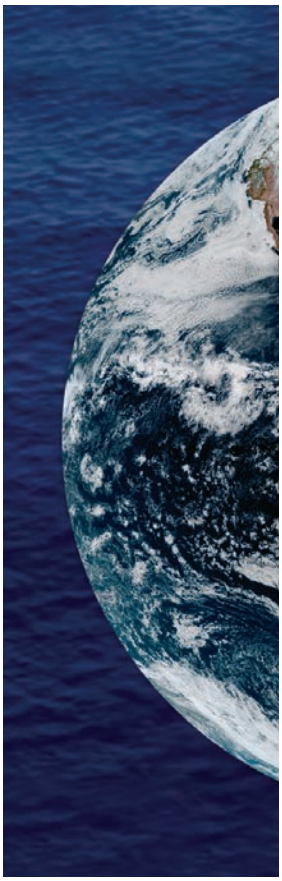


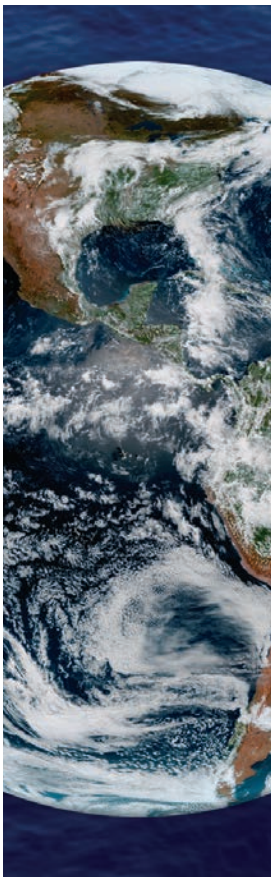
Combined Budget: $1.7B

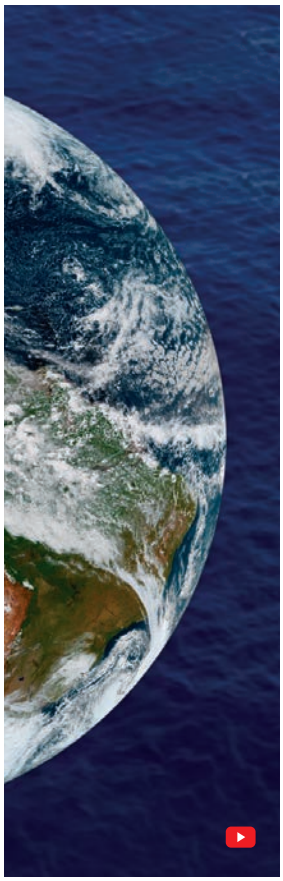
Combined Goddard Budget Percentage: 35%

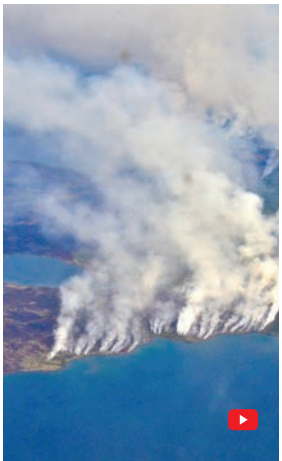
- Facilities:
  - Greenbelt
  - Wallops
  - GISS
- 13 Labs/Offices
- 1,400+ Staff

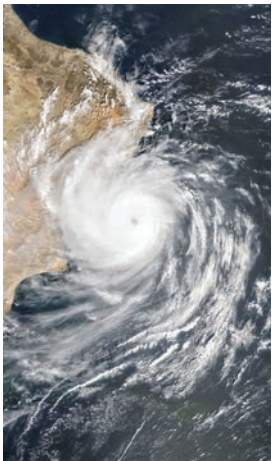


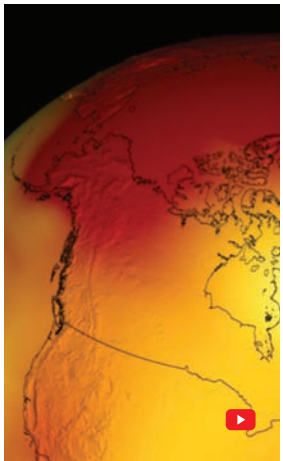




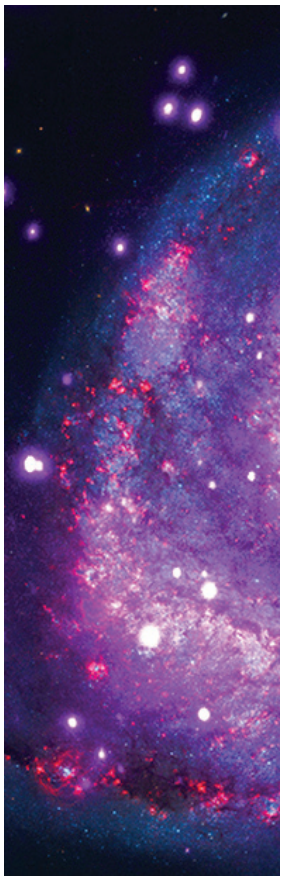
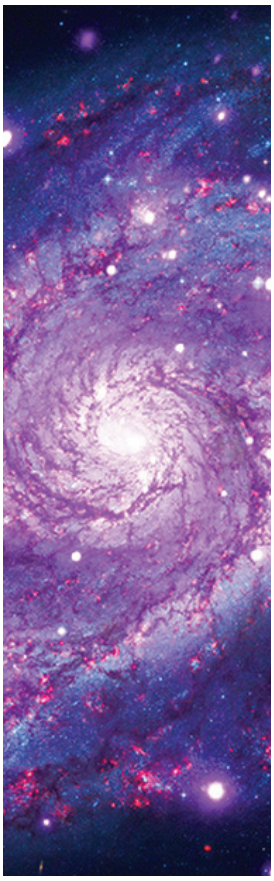








ASTROPHYSICS

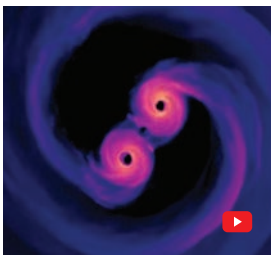
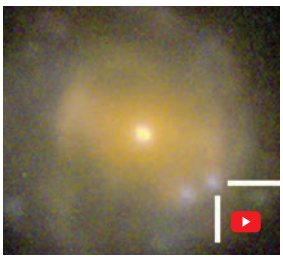



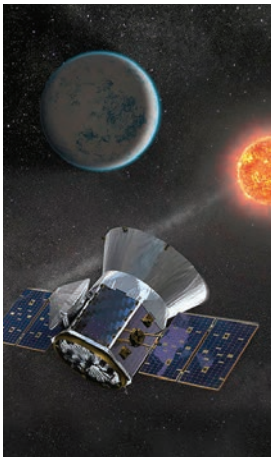


Budget: $1.0B

Goddard Budget Percentage: 20%

- Facilities:
  - Greenbelt
  - Wallops
- 5 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
- High-Resolution Mid-Infrared Spectrometer (HIRMES) for SOFIA
- James Webb Space Telescope
- Laser Interferometer Space Antenna (LISA)*
- High-Resolution Microcalorimeter X-ray (Micro-X)
- Primordial Inflation Explorer (PIXIE)
- Wide-Field Infrared Survey Telescope (WFIRST)
- X-Ray Imaging and Spectroscopy Mission (XRISM)*

OPERATIONAL MISSIONS AND INSTRUMENTS

- CALorimetric Electron Telescope (CALET)*
- Fermi Gamma-ray Space Telescope
- HaloSat
- Hubble Space Telescope
- International Gamma-Ray Astrophysics Laboratory (INTEGRAL)*
- Neutron star Interior Composition ExploreR (NICER)
- Nuclear Spectroscopic Telescope Array (NuSTAR)
- Neil Gehrels Swift Observatory
- 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

https://science.gsfc.nasa.gov/astrophysics/

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.

MISSIONS IN DEVELOPMENT

- Atmospheric Waves Experiment (AWE)
- Ionospheric Connection Explorer (ICON)
- Polarimeter to Unify the Corona and Heliosphere (PUNCH)
- Solar Orbiter*
- Tandem Reconnection and Cusp Electrodynamics Reconnaissance Satellites (TRACERS)

OPERATIONAL MISSIONS

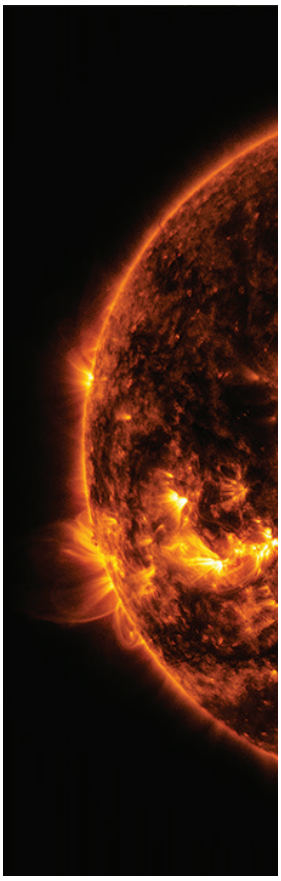
- Advanced Composition Explorer (ACE)
- Aeronomy of Ice in the Mesosphere (AIM)
- Deep Space Climate Observatory (DSCOVR)*
- Geotail*
- Global Observations of the Limb and Disk (GOLD)
- Hinode*
- Interface Region Imaging Spectrograph (IRIS)
- Interstellar Boundary Explorer (IBEX)
- Magnetospheric Multiscale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

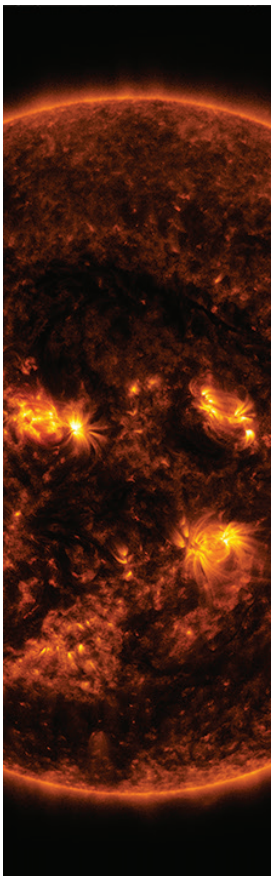
*Joint Agency Satellite

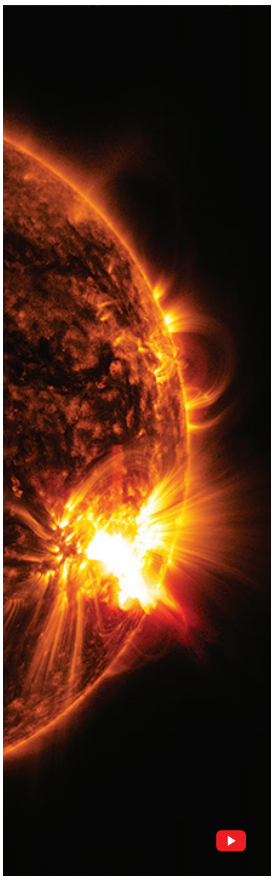
https://science.gsfc.nasa.gov/heliophysics/

Budget: $319.3M

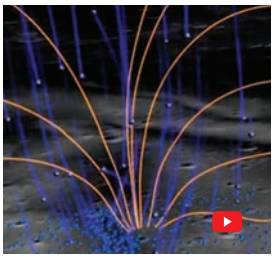
Goddard Budget Percentage: 7%

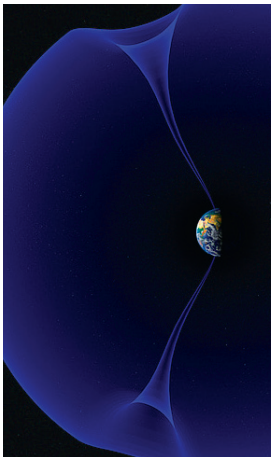




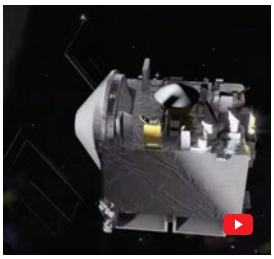


- Facilities:
  - Greenbelt
  - Wallops
- 5 Labs/Offices
- 350+ Staff





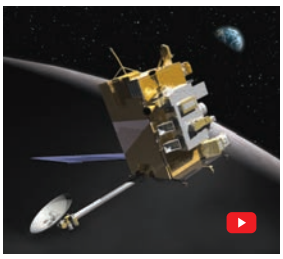
PLANETARY SCIENCE

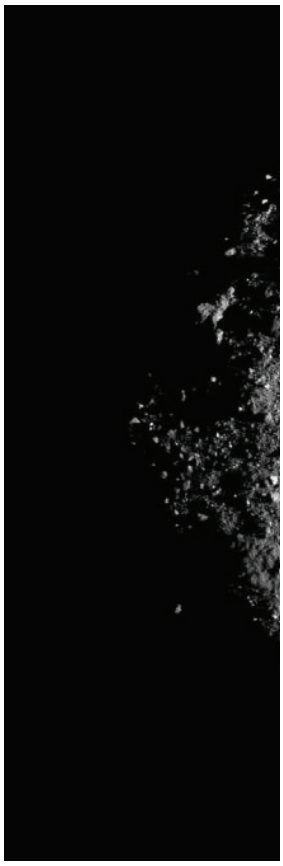


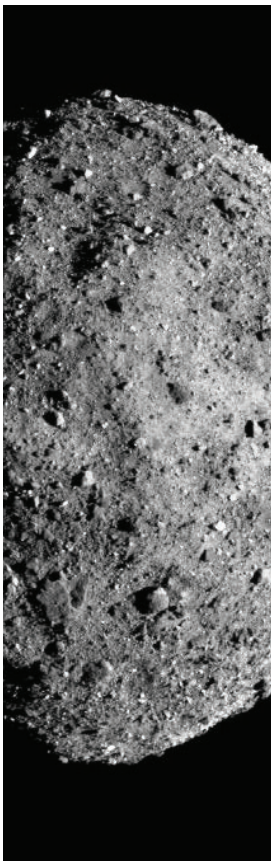
Budget: $424.9M

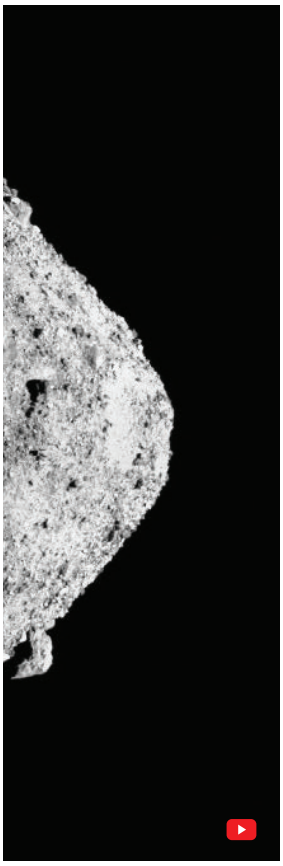
Goddard Budget Percentage: 9%

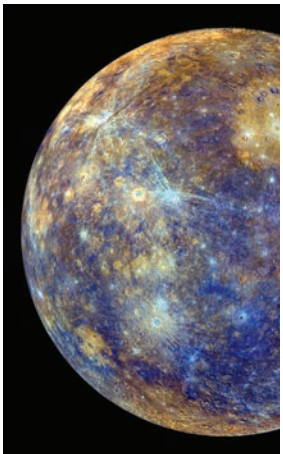
- Facility:
  - Greenbelt
- 6 Labs/Offices
- 323 Staff











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

- Lucy
- Commercial lunar lander instruments (4), including mass spectrometers, a magnetometer and search coils
- Dragonfly Mass Spectrometer (DraMS)
- L'Ralph for Lucy
- Mass Spectrometer for Mars Organic Molecule Analyzer (MOMA) on ExoMars
- Search coils on the BEAM Plasma Interaction Experiment (BEAMPIE) and Space Measurement of A Rocket-release Turbulence (SMART) mission
- Thermal Infrared Sensor-2 (TIRS-2) for Landsat 9

OPERATIONAL MISSIONS AND INSTRUMENTS

- Lunar Reconnaissance Orbiter (LRO)
- Mars Atmosphere and Volatile Evolution mission (MAVEN)
- Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer (OSIRIS-REx)
- LEISA for New Horizons Ralph Camera
- Lunar Orbiter Laser Altimeter (LOLA) for LRO
- Magnetometers for Deep Space Climate Observatory (DSCOVR), ACE, Juno, MAVEN, Van Allen Probes, Voyager and Parker Solar Probe
- Neutral Gas and Ion Mass Spectrometer (NGIMS) for MAVEN
- OSIRIS-REx Visible and Infrared Spectrometer (OVIRS)
- Sample Analysis at Mars (SAM) instrument suite on Mars Curiosity rover
- Search coils on USAF/DSX
- Thermal Infrared Sensor (TIRS) for Landsat 8

*Joint Agency Satellite

https://science.gsfc.nasa.gov/solarsystem/

SPACE COMMUNICATIONS AND NAVIGATION

Space communications and navigation are pivotal in enabling NASA's mission. These capabilities, along with their continued development, provide astronauts and spacecraft the critical connection needed to communicate with Earth and transmit valuable science data.

Goddard manages operations for two of NASA's networks, the Near Earth Network and Space Network, which collectively transmit and receive 98% of NASA's data. Goddard also performs cutting-edge research and advances communications technology, network capabilities and exploration to anticipate the evolving needs of NASA and other partners.

MISSIONS IN DEVELOPMENT

- Integrated LCRD LEO User Modem and Amplifier Terminal (ILLUMA-T)
- Laser Communications Relay Demonstration (LCRD)
- Laser-Enhanced Mission Communications Navigation and Operational Services (LEMNOS)

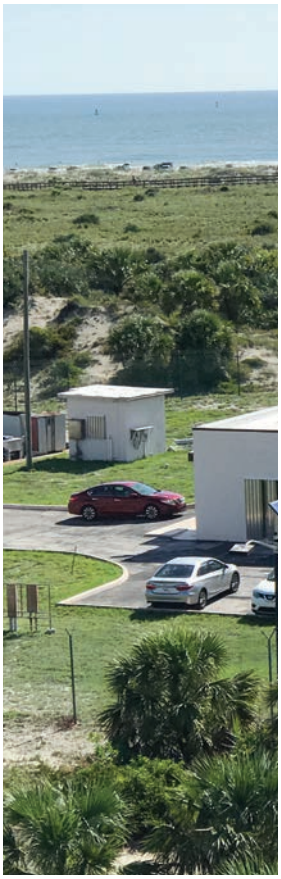
OPERATIONAL MISSIONS

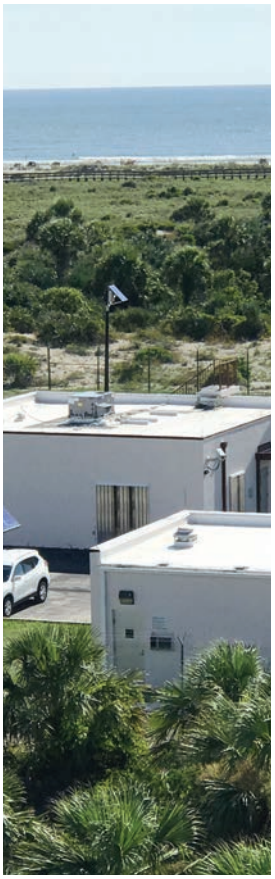
- Tracking and Data Relay Satellite-3, 5-13 (TDRS-3, 5-13)

https://esc.gsfc.nasa.gov

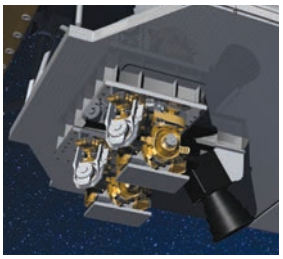
Budget: $399.3M

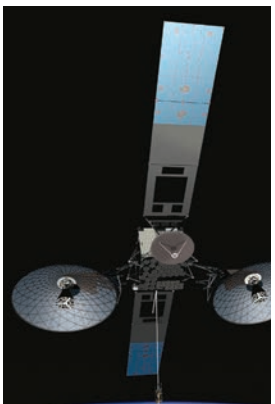
Goddard Budget Percentage: 8%





- Facilities:
  - Greenbelt
  - Wallops
  - White Sands
- 3 Labs/Offices



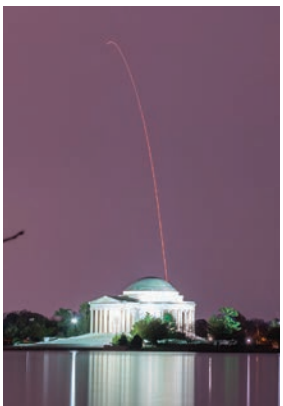


SUBORBITAL PROGRAMS AND RANGE SERVICES

Budget: $143.5M

Goddard Budget Percentage: 3%

- Facilities:
  - CSBF
  - Wallops
  - White Sands
- 6 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 range from research aircraft, unmanned aerial systems, high-altitude balloons, and suborbital and orbital rockets.

MISSIONS IN DEVELOPMENT

- HaloSat and TROPICS small satellite missions
- National Reconnaissance Office launch
- Rocket Lab's first flight from Wallops, launch pad construction
- Scientific balloon missions (17)
- Sounding rocket missions (20)

OPERATIONAL MISSIONS

- Airborne Carbon and Transport – America (ACT-America)
- Cloud and Aerosol Monsoonal Processes – Philippines Experiment (CAMPEX)
- Grand Challenge Initiative
- Northrop Grumman missions for two Antares launches
- Observation of Aerosols above Clouds and their intEractionS (ORACLES)
- Operation IceBridge
- SmallSat program management and development

https://www.nasa.gov/wallops

ORBITAL SERVICING AND ASSEMBLY

Goddard is pioneering in-orbit servicing, assembly and manufacturing capabilities to enable exploration and science missions, from extending the life span 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.

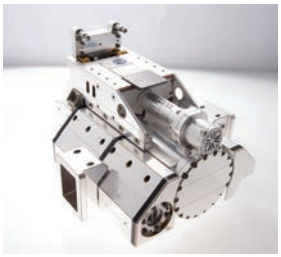
MISSIONS IN DEVELOPMENT

- Alpha Magnetic Spectrometer (AMS) Repair Mission (Tools Support)
- Restore-L
- Robotic External Leak Locator 2 (RELL2)
- Robotic Tool Stowage (RiTS)

OPERATIONAL MISSIONS

- Raven
- Robotic Refueling Mission 3 (RRM3)

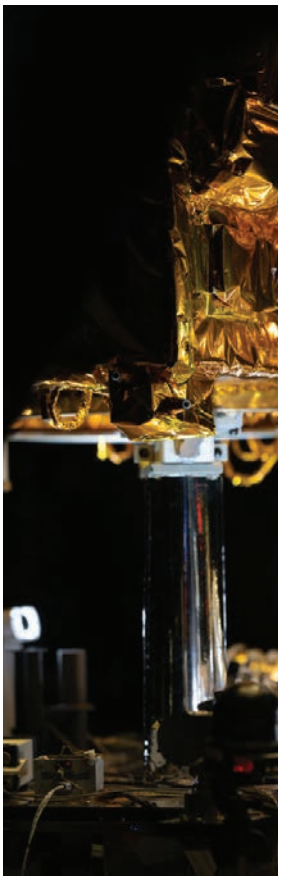
https://sspd.gsfc.nasa.gov

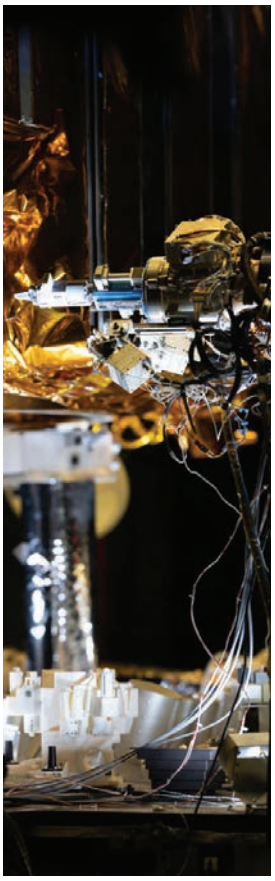


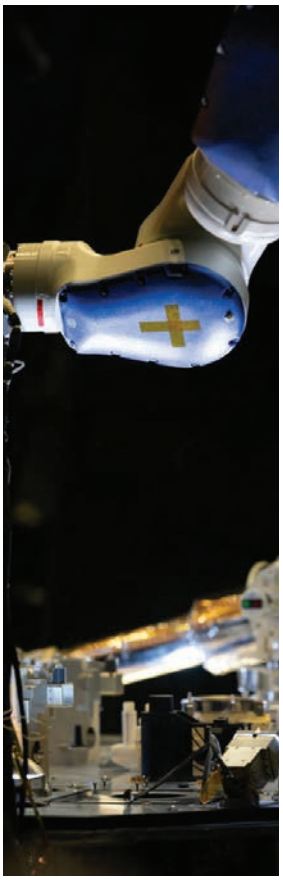
Cross-Cutting Technologies and Capabilities

Budget: $281.5M

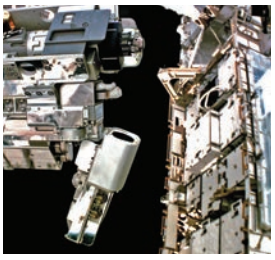
Goddard Budget Percentage: 6%

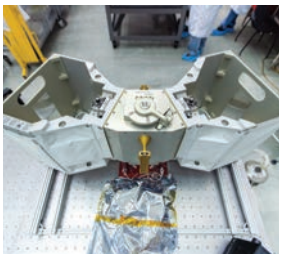


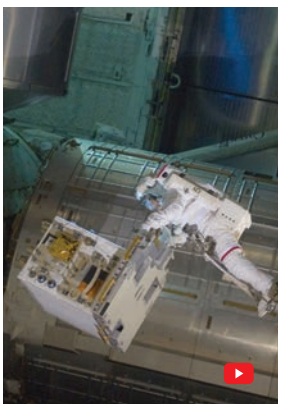


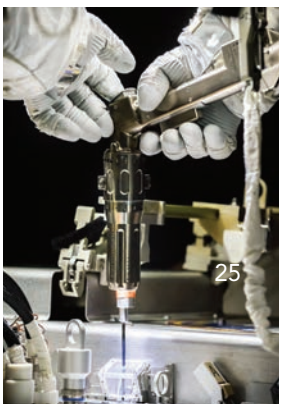


- Facility:
  - Greenbelt









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

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 Goddard Visitor Center, tours and public engagement events provide an opportunity to directly engage with our work. Multimedia resources allow external news organizations and others to access Goddard's activities and subject matters experts. As social media has become more prominent, Goddard has developed large followings across multiple platforms for its own accounts and others on behalf of the agency.

SOCIAL MEDIA FOLLOWERS

- 1.2+ MILLION
- 2.5+ MILLION
- 568,000+
- 608,000+

EDUCATION

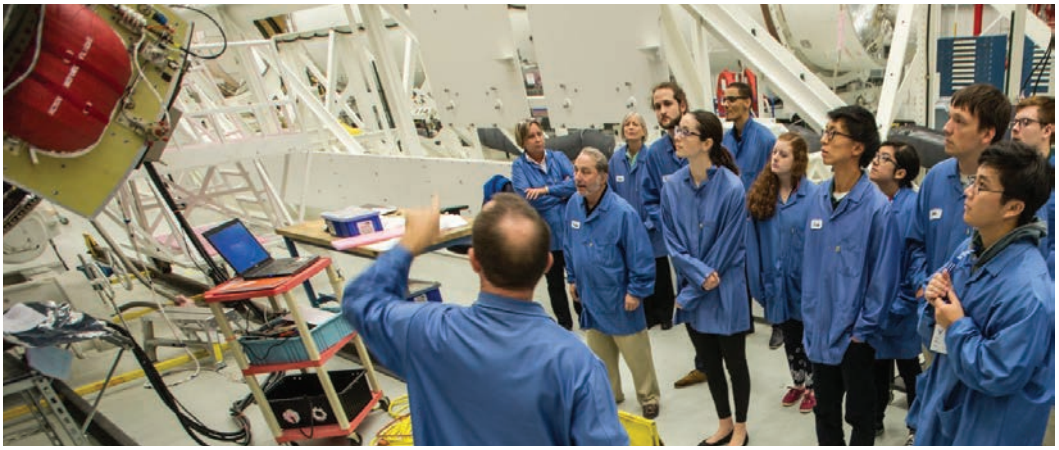
The Goddard Office of Education immerses students and educators at all levels of NASA's work, enhances STEM literacy and inspires the next generation to explore.

A student engages in a virtual reality exhibit at the Goddard-sponsored Earth Day event in Washington, D.C.

The Katherine Johnson Independent Verification & Validation Facility hosts teams for the FIRST® LEGO® League Mountain State Open Invitational robotics competition at Fairmont State University in West Virginia.

Students speak to astronauts aboard the International Space Station.

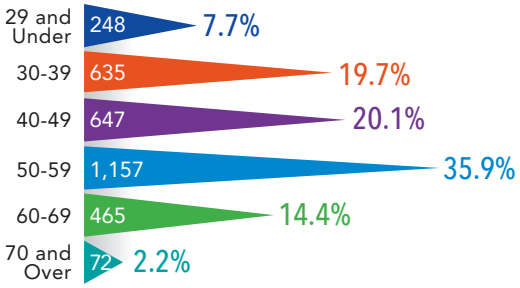
Goddard scientist C. Alex Young speaks to attendees at the International Society for Technology in Education conference in Philadelphia about accessibility and space science communication.



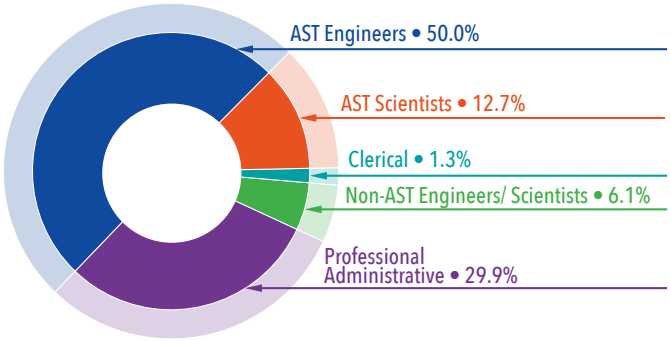
For the second year, Wallops hosted the NASA Community College Aerospace Scholars program with participants from five states.

State of the Workforce 2019

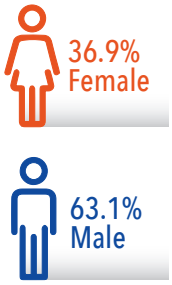
GODDARD CIVIL SERVANTS by Age Group



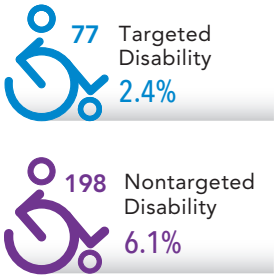
GODDARD CIVIL SERVANTS by Skill Mix



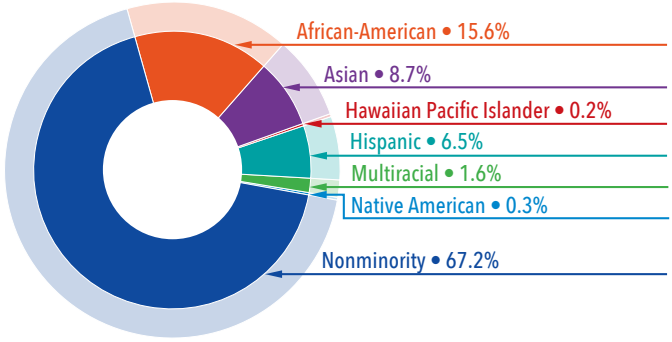
GODDARD CIVIL SERVANTS by Gender



GODDARD CIVIL SERVANTS by Disability



GODDARD CIVIL SERVANTS by Ethnicity



NASA's Goddard Space Flight Center values the diversity of experiences, viewpoints and talents of its employees. Diversity, inclusion and equal opportunity are vital to the center's mission, helping to drive innovation, collaboration and creativity along the path to mission success.

Diversity and inclusion and equal employment opportunity advisory committees across the center ensure that the interests of employees from all backgrounds are represented in recruitment, hiring, retention, outreach and professional development.

BUDGET

Goddard Program Year 2019 Budget

Categorized by Lines of Business (as of Sept. 30, 2019)

BUDGET: $4.9B

DIRECT GODDARD BUDGET: $3.9B
REIMBURSABLE GODDARD BUDGET: $1.0B

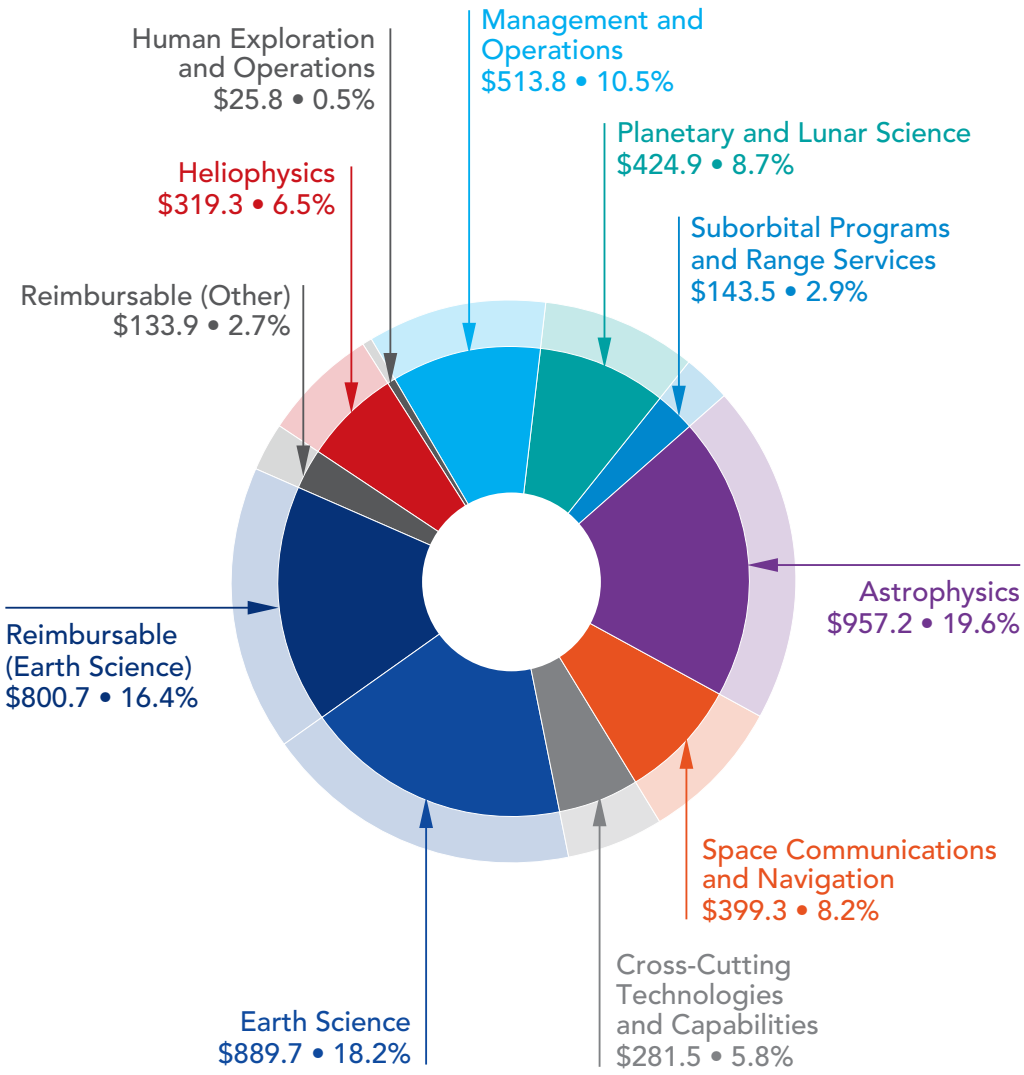


Chart Is in $Ms

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:

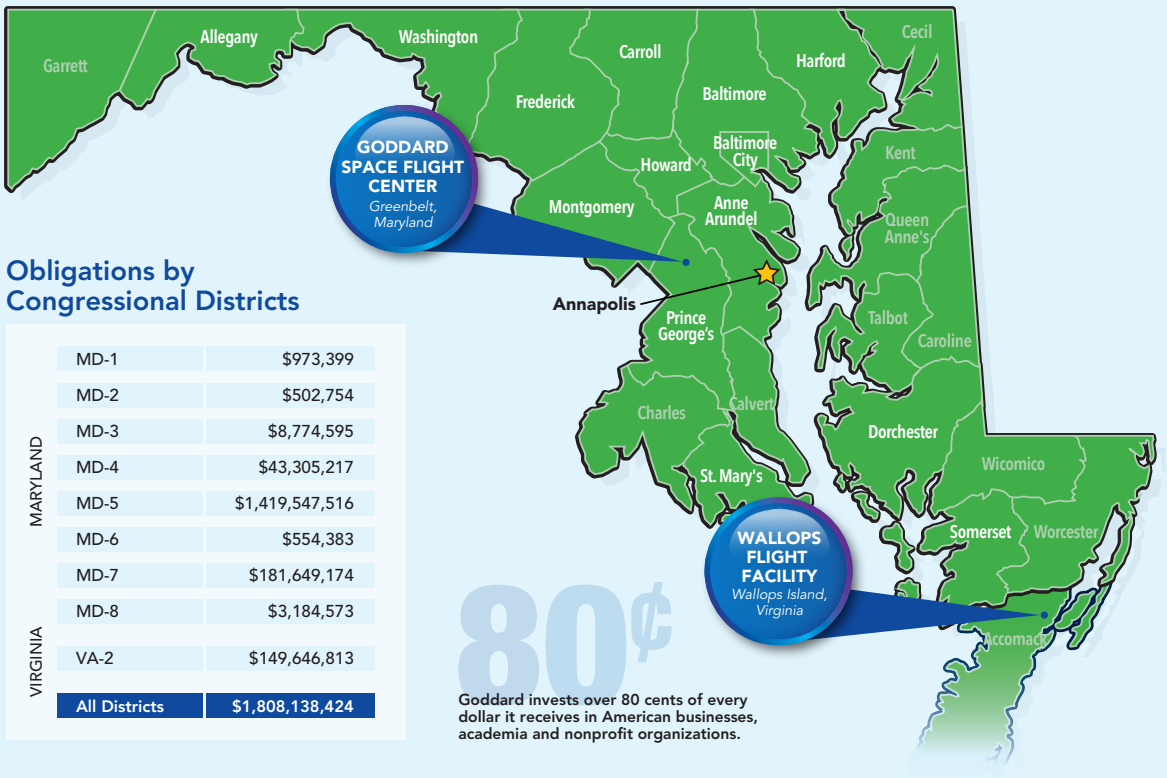
- Expending goods and services to perform its mission.
- Generating technology transfer and spinoff activities.
- Broadening small business opportunities through its robust contracting program.

Obligations by State

District of Columbia	$17,147,381
Delaware	$1,692,816
Maryland	$1,658,491,615
New Jersey	$12,857,492
New York	$131,611,417
Pennsylvania	$12,231,282
Virginia	$249,375,560
West Virginia	$42,636,994

Obligations by Maryland County

Allegany	$2,475	Harford	$335,125
Anne Arundel	$1,695,292	Howard	$13,243,379
Baltimore	$13,535,344	Montgomery	$3,775,511
Baltimore City	$163,721,879	Prince George's	$1,461,462,005
Carroll	$529,193	St. Mary's	$41,995
Dorchester	$80,063	Somerset	$23,000
Frederick	$5,000	Washington	$41,349
Total	**$1,658,491,615**		



Obligations by Congressional Districts

MARYLAND	MD-1	$973,399
	MD-2	$502,754
	MD-3	$8,774,595
	MD-4	$43,305,217
	MD-5	$1,419,547,516
	MD-6	$554,383
	MD-7	$181,649,174
	MD-8	$3,184,573
VIRGINIA	VA-2	$149,646,813
	All Districts	**$1,808,138,424**

80¢

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

Goddard's Top Contractors

1.	LOCKHEED MARTIN CORPORATION	$211.2 M
2.	NORTHROP GRUMMAN SPACE AND MISSION SYSTEMS CORPORATION	$210.2 M
3.	HARRIS CORPORATION	$188.9 M
4.	PERATON INC.	$179.9 M
5.	SCIENCE SYSTEMS AND APPLICATIONS, INC.	$162.7 M
6.	ASSOCIATION OF UNIVERSITIES FOR RESEARCH IN ASTRONOMY, INC.	$144.7 M
7.	SCIENCE APPLICATIONS INTERNATIONAL CORPORATION	$139.0 M
8.	GENERAL DYNAMICS MISSION SYSTEMS, INC.	$124.8 M
9.	KBRWYLE TECHNOLOGY SOLUTIONS, LLC	$105.4 M
10.	ORBITAL ATK	$101.0 M

All numbers are based on NASA Procurement Data View and FPDS obligation data for fiscal 2019 as of Oct. 7, 2019. Obligated funds, both Goddard and NASA Shared Services Center.

AWARDS

American Astronautical Society

American Astronautical Society ISS Compelling Results Award

NICER Team

AGU 100 ADVANCING EARTH AND SPACE SCIENCE

American Geophysical Union

Athelstan Spilhaus Award
C. Alex Young

Cryosphere Early Career Award
Ludovic Brucker

Excellence in Earth and Space Science Education Award
Mark Chandler

Fellows
Mei-Ching Fok
Dorothy Hall
Christa Peters-Lidard
Gavin Schmidt

Jule Gregory Charney Lecture
Paul Newman

Outstanding Reviewer
Gina DiBraccio Riemer

American Meteorological Society

Fellows
Scott Braun
George Huffman

Joanne Simpson Mentorship Award
Anne Douglass

Clarivate Analytics

Clarivate Analytics Highly Cited Researchers List

Mian Chin
Jeff Masek
Ben Poulter
Matthew Rodell
Gavin Schmidt

IACS International Association of Cryospheric Sciences

International Association of Cryospheric Sciences Early Career Award

Dennis Felkison

IPC

IPC Stan Plzak Corporate Recognition Award

NASA

Executive Office of the President of the United States

Presidential Early Career Awards for Scientists and Engineers

Giada Arney
Shawn Domagal-Goldman
Jennifer Stern

USGS science for a changing world

U.S. Geological Survey William T. Pecora Award

Ozone Monitoring Instrument International Team

USGIF United States Geospatial Intelligence Foundation

U.S. Geospatial Intelligence Foundation Academic Achievement Award

Aaron Gerace
Matthew Montanaro

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 2018 through September 2019 include:

SALLY BARCUS
STEVEN SCOTT

‡Contractors, former civil servants and others whose reported passing occurred from October 2018 through September 2019 include:

RICHARD A. AUSTIN
WILLIAM F. BANGS
WESLEY J. BODIN JR.
DORA L. CARLE
WILLIAM D. CARPENTER
ROBERT E. CARR SR.
CHARLES C. CASTO
JOSEPH PATRICK MICHAEL CORRIGAN III
GEORGE E. CROFT
DAVID L. DAVIS
JOSEPH J. ECK
JIMMIE C. ELSWICK
TON L. ENG
MARK E. ERICKSON
DELORIS J. FINCH
JOHN E. FIRMIN
WALTER T. FLOURNOY
JAMES C. FLOYD
STAMER C. GEMINDEN JR.
RAYMOND L. GRANATA
BRANDON WILLIAM HANEY
RICHARD E. HARTLE
JEAN E. HUBBARD
THOMAS HUBER
JOHN A. HUGHES
ARTHUR H. JACKSON
THOMAS M. JANOSKI
JAMES L. JEW
FRED L. KING
DANIEL A. KLINGLESMITH III
ALBERT D. LATZKO
FRANCIS J. LOGAN
PAMELA MAXWELL
STEPHEN G. MCCARRON
EARL R. MOYER
JOSEPH A. MULLER
ALEX P. NAGY
PHILLIP A. NEWMAN
RICHARD NOVARIA
ROBERT L. OWEN
ANGELINE C. PUGLISI
JAMES J. RAST
ROBERT W. RHODES III
MICHAEL F. ROBERTS
NANCY G. ROMAN
FRANCIS P. RUSSO
JOHN SCHULTHEIS
MICHAEL C. SHAI
LAWRENCE P. SKISCIM SR.
DON SMITH
DANA SOUTHWOOD
PAUL SPUDIS
JAMES M. STEVENS
PATRICIA A. STONE
GRANVILLE L. TAYLOR
VIRGIL TRUE
ROBERT S. WATSON
RICHARD J. WIRTH
JOHN J. WOLFF JR.

*NASA does not have access to this information for former NASA civil servants. The report authors have been informally notified of such individuals who have been added to the list under contractors and others.

‡NASA does not have access to this information for contractors and others affiliated with Goddard. An earnest attempt was made to manually collect this information. However, the nature of the process could result in an incomplete list.

Please email omissions to Darrell Dela Rosa at darrell.d.delarosa@nasa.gov. The electronic version of this report will be updated accordingly.

Goddard
SPACE FLIGHT CENTER

There can be no thought of finishing, for aiming at the stars, both literally and figuratively, is the work of generations, but no matter how much progress one makes there is always the thrill of just beginning.

– Robert H. Goddard

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

NP-2019-8-418-GSFC