National Aeronautics and Space Administration

Goddard Space Flight Center

Annual Report 1999

Table of Contents

Cover Photo: Artwork by Pat Rawlings, Space Artist and Conceptual Designer, SAIC.

Message from the Director

I am very pleased to share with you the last annual report from the Goddard Space Flight Center for the 1900s! During 1999, we celebrated our 40th Anniversary and this event gave us a moment in time to educate and refresh ourselves about our past as well as envision the future. We are "proud of our past and prepared for the future."

This is our report card to you on the Center. We want to describe where we are today with our goals and plans; how employees and Center processes are making safety a priority in everything we do; our commitment to quality to include management and systems; our success and status in meeting commitments for the year; highlights of scientific and technological leadership; the impact of Project Goddard; our economic impact for the year; the continuing emphasis in community relations to include education programs that make a difference; and, finally, a report card from you. This year we're adding a feature of customer feedback: How do our clients and customers perceive us?

In the report, you will see quotes from members of the Executive Council on their perspectives for 1999. Given the vast array of activities, from launching Landsat-7, to becoming certified for ISO 9001, I must congratulate each member of the Council for his/her leadership and dedication. I appreciate and rely on the Executive Council as the principal arm in the Center's organization to enable employees and others to achieve the Center's goals and objectives.

This past spring, during the Anniversary activities, I visited with former Goddard Center Directors; and in Harry Goett's absence I met with the First Family of Goddard, his children and grandchildren. For me, such an opportunity released an enormous amount of energy and appreciation of the challenges, difficulties, hardships, celebrations and achievements of so many people who wore a Goddard badge over the course of 40 years. Every Center Director offered a special story and, taken together, these blended into a mosaic of what we are today. If we are successful, it's because the work is achieved by people; if we enjoy a reputation for excellence, it's because of the efforts made by people; and if we grow and achieve further recognition by our peers and the world, it's because of the attitudes of our people. I am convinced that the strength of Goddard has been and always will be its family.

As you read this report, please reflect on the many employees who dedicate their efforts to the quality, progress and accomplishments described here. This document offers only examples of the many contributions made by our work force. Every person at Goddard can and does make a valuable contribution to the mosaic of the Center. We are looking forward to the adventures of the next century and with our talented and skilled people, we will step up to the challenges in Robert Goddard's tradition of "The dream of yesterday is the hope of today and reality of tomorrow."

A. V. Diaz, Director

"From participating in the Center's 40th anniversary celebration, to restoring the Nation's land remote sensing capability with the successful launch and activation of Landsat-7, to getting our hard-earned ISO certification, it's been a busy but extremely successful and productive year. Congratulations to the Goddard team for making all this, and more, possible!"

Bill Townsend, Deputy Director
Goddard Space Flight Center

Where are We Today?

As the Goddard Space Flight Center celebrates 40 years of distinguished service to the American public and the world at large, the Center is anticipating the challenges of the new millennium with renewed commitment and determination. GSFC is committed to achieving its mission as NASA's Center of Excellence for Scientific Research and increasing its preeminent position in scientific research, aligned with the Agency's Space Science and Earth Science Enterprises. The Center also is determined to achieve a competitive edge to make Goddard the supplier of choice as the world seeks answers to increasingly complex and far-reaching questions related to the Earth, its solar system and the entire universe. From the first images of Earth seen from space, made possible in 1959 from the Goddard-managed Explorer VI, through deployment of Landsat-7 in 1999 and its specialized capabilities in global change research and land-use applications, the Center's spirit and commitment to excellence is exemplified in every flight project, science mission and technological advance.

Goddard at 40:
Proud of the Past,
Prepared for the Future

Goddard's vision is an ambitious one: "We revolutionize knowledge of the Earth and the universe through scientific discovery from space to enhance life on Earth." To provide clarity and focus in the achievement of mission objectives, a five-point plan was developed that guided the work efforts for 1999. This report follows these themes:

- First and foremost, the Center confirmed safety as its number one value, including the safety of individual employees, mission safety and the safety of high-value hardware. Actions are underway to change the Center's culture from assigned organizational responsibility to individual responsibility for safety.
- Another priority for Goddard was achieving ISO 9001 certification, which demonstrates to Goddard's customers an unwavering commitment to quality products that produce reliable results at an affordable cost. Upon review in August, ISO auditors recommended that the Center be certified.
- A third theme is meeting commitments and keeping our promises. The Center is committed to the safe, on-time launch of Goddard missions, spacecraft and instruments, preparing for full-cost accounting and ensuring all mission-critical systems are year 2000 compliant.
- Another key message is maintaining scientific and technological leadership in space and Earth science, as we continue to focus on assuring that our space and Earth science performance is unequivocally world-class and cutting-edge.
- Finally, to pull these activities together, the Center continues its focus on Project Goddard. In addition to activities begun last year to provide unified leadership to achieve Center goals and mission objectives, Project Goddard defined Center core competencies and the development of an Integrated Business Plan to ensure business systems and practices will support Center goals.

Strategic Implementation Plan

Goddard's Strategic Implementation Plan was a framework to identify where the Center's priorities should lie. The plan confirms the vision statement for the Center, consistent with its Center of Excellence and mission roles and responsibilities, along with supporting goals and strategies linked with the NASA Strategic Plan, Enterprise Plans, and the Agency Performance Plan. Also included are seven values which define the Center's culture and are used as guiding principles in the decisions which it makes: Agility, Balance, Creativity, Dedication, Integrity, Respect and Teamwork.

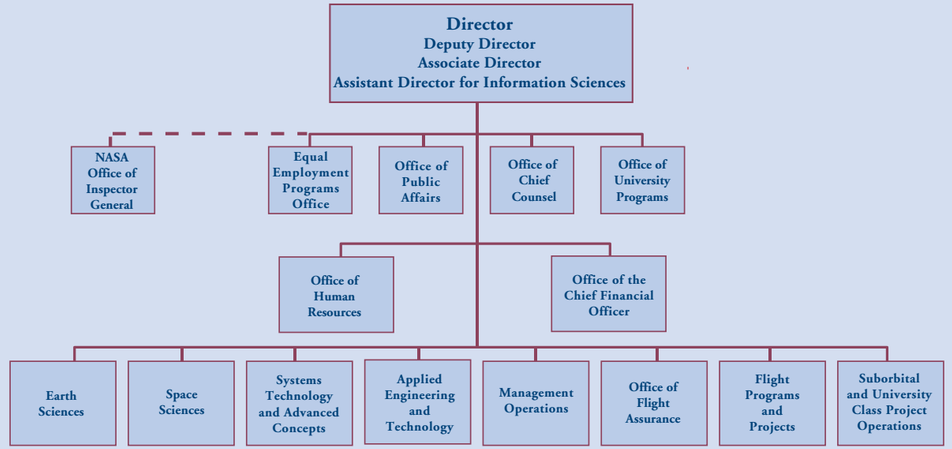
Goddard's Mission

Goddard's mission to enable discovery through leadership is the foundation for the Earth and space sciences making this Center unique to the Agency, framing its commitment to its customers. As the Center continues to operate in an environment of limited resources, it is dedicated to pursuing science missions which best serve the needs of the scientific and education communities and the Nation at large, within the framework established by the Agency's Space Science and Earth Science Enterprises.

Centerwide Goals

Six Centerwide goals and supporting strategies form the framework for the Center's annual goals, performance targets and actions. This past year saw each Directorate develop an operating plan linking its operational goals and objectives to those of the Center. To ensure that each employee understands how his or her role fits into the Center's mission, individual performance plans now identify the employee's key performance element and how it links to one or more of the six Center goals. Employees can see how their contributions relate to the flow, from individual requirements to Center and Agency goals. The goals are:

- to serve as a national resource for discovery in Earth and space science and technology development;



- to be an international Center of Excellence for research on Earth science, space science and technology;
- to enhance the Nation's technological and scientific literacy by sharing the information and knowledge that result from the performance of Goddard's mission;
- to accomplish the Center's mission through a vital and effective work force;
- to maintain and upgrade Goddard's core infrastructure, laboratory facilities and equipment to preserve the Center's preeminence as a national resource and Center of Excellence;
- to organize science, technology, flight mission and business processes to achieve greater productivity.

Organizational Structure

The Center implemented a restructuring activity in 1999 related to its Earth and space science program management responsibilities. This activity strengthened the overall management of Earth and space science activities within the Agency and is compliant with the NASA Strategic Management Handbook. This restructuring folded together the Associate Director for Earth Science and the Associate Director for Space Science into one Associate Director position responsible for program integration at the Center level. Implementation of science mission programs assigned to GSFC will now be the responsibility of the Program Manager in the renamed Flight Programs and Projects Directorate. Integration of all programs comprising the Earth Science Enterprise will now be the responsibility of the Office of Earth Sciences at NASA Headquarters.

"Realizing that people are our most important asset, we were really excited that the hiring freeze ended so that we could get started building for the future of the Center work force."

Jerry Simpson, Chief
Office of Human Resources

Employee Facts and Figures

Some of the world's premier scientists and engineers comprise the Goddard team. Its work force is predominantly technical and is highly educated. On its 40th anniversary, it is interesting to see how the composition of the Center has changed over time:

Civil Servants by Skill Group

	FY59		FY99	
	# of Work Force	% of Work Force	# of Work Force	% of Work Force
Clericals	249	22.7	231	7.2
Prof. Admin.			823	25.6
Sci. & Eng.	610	55.7	1871	58.2
Technicians	154	14.1	230	7.2
Wage Grades	83	7.6	61	1.9

Highest Degree Earned of Employees Currently on Board

	# of Work Force	% of Work Force
Ph.D.	439	13.7
Masters	609	18.9
Bachelors	1278	39.7
Associate	116	3.6
No Degree	774	24.1

Safety is Number One

At Goddard we recognize that "mission success starts with safety." The safety of the public, our astronauts and pilots, our work force, our mission and our high-value facilities and equipment is our greatest concern and our highest priority. This year the Center initiated the Goddard Safety Initiative to personalize and drive home the Agency Safety Initiative. The initiative underscores how:

- line management is accountable for safety;
- every employee is responsible for safety;
- the professional safety organizations are available to facilitate and advise employees.

The Center's goal is to eliminate all lost-time mishaps. "Every accident results in human suffering, lost dollars, inefficiency and a possible blemish on our reputation. Good is not good enough. This is an area in which we aim for perfection," says Alda Simpson, Associate Director, Systems, Technology, and Advanced Concepts Directorate and Center lead for the safety initiative.

The Goddard Safety Council was reformed as the Safety, Health and Environmental Committee, chaired by the Center Director, and includes all senior managers, safety leads and representatives from the bargaining units of our unions. The Center's Deputy Director is leading a Contractor Safety Forum to bridge the Center's policies with our contractor community and the Center's Associate Director is leading an Employee Safety Forum.

The Safety Initiative touches everyone at the Center, including our visitors. For example, the Center map highlights safety guidance and key phone numbers. When visitors sign in for extended stays, they will acknowledge this resource and demonstrate they know how to contact individuals for safety guidance as well as view an informative video about safety issues.

As part of the Safety Initiative, a risk assessment to determine vulnerabilities of each building on Center will be used to select higher-risk facilities for more detailed assessments. Examining our aging facilities for safety factors is a growing need as time passes.

For Goddard employees, training and tools strengthen our position to secure a safe environment. During 1999, our entire work force participated in a safety in-service day. To focus on safety, personnel viewed the safety videos, reviewed a safety pocket guide, gathered preliminary risk assessment data and reviewed safety plans and emergency procedures.

Supervisors' safety handbooks, another important tool, gives managers the resources they need to focus attention on safety in their organizations and to perform easily the required analyses and assessments.

A new database, which allows people to enter information on either close calls or hazards, is online to provide employees with a fast way to make a report and to get feedback on what is happening to repair the hazard.

The safety emphasis does not stop at work. By making our work force more sensitive to safety at work we hope employees, civil servants and contractors alike, will be more careful at home, where many accidents happen.

The Center believes that people are our most cherished resource and their health, safety and well-being at work, home or play is vital to our successes.

"During 1999 we've led the Center into new ways of looking at safety awareness and taking personal responsibility."
Charles Vanek, Director
Office of Flight Assurance

Goddard's Commitment to Quality

In late 1996, the Agency set a goal to be in the forefront of quality management just as it was in its scientific and engineering advancements. To demonstrate achievement in this area, the entire Agency would seek certification to ISO 9001 by the end of Fiscal Year 1999. In meeting this Agency goal, GSFC accomplished its first ISO 9001 milestone with the successful completion of a registration audit by Det Norske Veritas (DNV) at the end of August 1999. The Center was granted ISO 9001 Certification that covers Scientific and Engineering Research and Development at the Center.

Preparing for ISO Certification, Goddard managers met frequently to plan and implement a Quality Management System.

This Certification is a significant milestone in Goddard's history. The receipt of the certificate, however, is only a piece of the story.

Goddard employees developed and implemented a Quality Management System to meet the requirements of ISO 9001, but also used this opportunity to provide a value-added approach to work as a preeminent research and engineering institution. The Center's intention was to meet the Agency's goal and focus on understanding and meeting customer requirements by applying excellence in everything we do. We sought ISO 9001 certification as well as a quality management system that fostered effective and efficient processes through continuous measurement and continual improvement. The Center believes in and supports a philosophy to include as much of the Center's work force and as many of its products under the ISO 9001 Standard as practicable. In particular, the scientific and engineering processes involved in the Center's scientific missions, ranging from research effort themes to the Center's role as program and project managers, are covered by the certification. To that end, the Center developed a list of the Center's five core processes and made these the subject of the Quality Management System. These include:

- Science Enabling
- Systems Development
- Program/Project Management
- Technology Enabling
- Mission Operations

The quest for certification began by understanding the ISO 9001 requirements and how these might be applied to the Center's work. A core group knowledgeable about ISO 9001 and its application to similar organizations along with a project office and a Centerwide steering committee led the aggressive schedule. The Center reviewed processes for compliance with the Standard, modified them as needed, and developed new processes to satisfy any remaining ISO 9001 requirements. The Project Office and the Quality Management System Council met frequently to work on the Quality Management System and reported often to senior managers regarding progress and issues that required high-level attention. More than a hundred employees were trained to serve as a resource for subcommittees to work on particular issues regarding ISO 9001.

The Council learned that many of the Standard's requirements were met in existing processes and that the largest task was to ensure that the processes were properly documented. In a few areas, such as document control, nonconformance reporting and supplier evaluation, the QMS Committee recommended and developed improved procedures that used a Center-level system to gather information. In other areas, including management review of the quality system and internal quality audits, the QMS Committee developed entirely new processes to meet specific requirements of the Standard. This gave the Center the opportunity to take a broad perspective on what to do to maximize the return on investment for oversight functions.

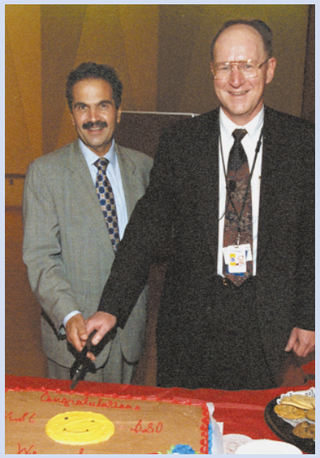
"1999 was a year of continued adaptation to change, one that clarified the advantages of the reorganization in many ways, and highlighted areas where additional effort is still needed. Although it may take some time to become more evident, I believe that the Goddard Integrated Business Planning Process will prove to be a tool of exceptional value."
Brian Keegan, Director
Applied Engineering and Technology Directorate (AETD)

One of the early Council decisions with immediate benefits was the use of the Internet to create systems available at any computer. The combination of centralized databases with decentralized points of entry gives employees immediate access to information, such as the current version of procedures and specifications, audit results, nonconformance reports, supplier performance data and engineering drawing information.

After taking a year to develop and implement the necessary procedures and processes and train personnel on their use, the Center declared the Quality Management System operational in early 1999.

In August, DNV conducted a Certification Audit of the Quality Management System and left with praise for the Center's efforts and the recommendation that the Center's entire Scientific and Engineering Research and Development efforts be certified as compliant with ISO 9001.

Goddard's ISO 9001 Certification not only helps fulfill the Agency's goal, but also provides for the continuing health and improvement of the Center as an organization and as a place to work. ISO 9001 certification gives the Center's customers an assurance that Goddard has and uses a documented quality system that emphasizes a commitment to quality, customer satisfaction and continual improvement. Maintaining ISO 9001 certification ensures that dedication to quality is a fixed element in Goddard's environment.



Center Director Diaz and ISO lead Vanek share a moment of celebration upon ISO 9001 Certification.

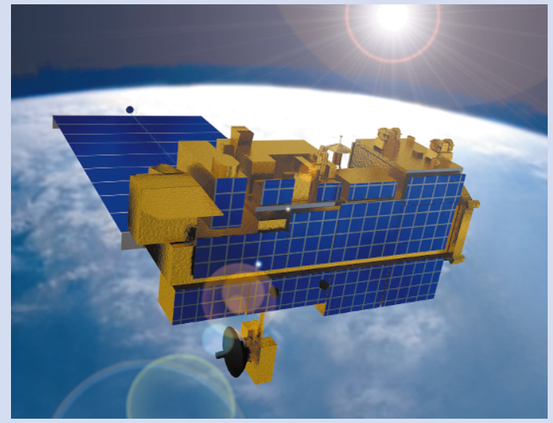
"One particularly noteworthy event for me was the celebration of GSFC's 40th birthday. This event was made possible by the incredible strength of our people and our institutional infrastructure — both of which enable the spectacular scientific research the Center is noted for. I believe that we, as a Center, must acknowledge the value of our people and infrastructure and make the necessary investment in each to ensure our success for the next 40 years."

Sharon C. Foster, Director
Management Operations Directorate

Meeting Our Commitments

The era of the Earth Observing System, EOS, arrived in 1999. The launch of Landsat-7 on April 15, 1999, marked the successful beginning of an unprecedented era in Earth studies. The anticipated Enhanced Thematic Mapper produced improved images for the Earth science community as well as state and local governments and natural resource management personnel, as well as other customers. The mission achieved operational status. The Alaska Ground Station and the Svalbard, Norway, Ground Station, the backbone of the EOS Polar Ground Stations, became operational to support the Landsat-7 mission.

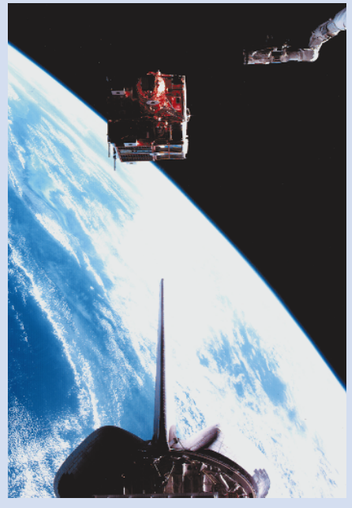
In other Earth science endeavors, Goddard and the Jet Propulsion Laboratory (JPL) partnered to fill the gap created in ocean wind measurements when the Japanese Adeos mission failed. JPL provided the Seawinds instrument and Goddard provided the spacecraft from the Rapid Spacecraft Development Office catalog. In less than 12 months the QuikScat mission was conceived, implemented and ready for launch. Due to launch vehicle problems the launch was delayed until June 19, 1999. One month later, July 19, 1999, the observatory was turned over for science operations.



Goddard manages the Earth Observing System including the flagship Terra spacecraft. Teams of scientists from all over the world will use the data from Terra to improve our understanding of the Earth.

Terra, the flagship of the Earth Observing System, represents the next landmark in NASA's leadership role to observe the Earth from the unique vantage point of space. Focusing on key measurements identified by a consensus of U.S. and international scientists, Terra will enable new research into the ways that Earth's lands, oceans, air, ice and life function as a total environmental system. The Terra Observatory was shipped from Valley Forge, Pa., in April for final transportation to the West Coast.

To meet the needs of the Earth science community, new missions are underway. For example, the Solar Radiation and Climate Experiment (SORCE) was confirmed. This is important because solar irradiance is the dominant energy source in the Earth's atmosphere, establishing much of the atmosphere's chemistry and dynamics. It becomes the dominant element in the global energy balance and an essential determinant of atmospheric stability and convection. The SORCE measurements will provide data to help us understand one of the primary climate system variables.



The Spartan 201 mission during John Glenn's return to flight put us much closer to unraveling the mystery of the acceleration of the solar wind.

The Alaska Ground Station in Chatanika, Alaska, serves as one of the critical ground stations for the Earth Observing System spacecraft because of the high-latitude location.

"While the year was tremendously exciting for the Center as a whole, what made this year stand out from a Wallops perspective was the continued successful implementation of Wallops Mission 2000 and the initiation of planning for Wallops Mission 2005."

Dr. Arnold Torres, Director
Suborbital and Special Orbital Projects

In support of space science activities, the Center's Flight Projects organization continued to provide management and direction to several high-visibility missions. The Hubble Space Telescope's next servicing mission and the Next Generation of Space Telescope development are on the top of the list. This year the flight of the Hubble Orbital Systems Test validated several new technologies that have far-reaching effects for other NASA missions. For example, the mechanical cryo-cooler system, the 486 computer, and the solid-state recorder all are now flight qualified. When a gyro on board the Hubble Space Telescope failed, Goddard reviewed the operational risks and concluded that at least one, if not more gyros, needed replacement before the scheduled servicing mission in late 2000. The third Hubble Servicing Mission will be implemented in two parts. And further, to meet the requirements of the users, the Space Telescope Operations Control Center was upgraded and all aspects of the project are year 2000 compliant.

Space shuttle (STS 103) crew of Mission 3A to the Hubble Space Telescope prepare themselves at Goddard's High Bay Clean Room. They use precise mechanical and electrical simulators to practice for the mission.

Launched in 1999, SWAS is a NASA Small Explorer Project designed to study the chemical composition of interstellar gas clouds.

The Explorer Program recorded four launches. The Submillimeter Wave Astronomy Satellite (SWAS) is a NASA Small Explorer Project designed to study the chemical composition of interstellar gas clouds. Its primary objective is to survey water, molecular oxygen, carbon and isotopic carbon monoxide emission in a variety of galactic star-forming regions. The SWAS Science Operations Center is located at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass.

The Wide-field Infra-Red Explorer, a partnership between Goddard and JPL, developed an on-orbit anomaly that prevents the spacecraft from carrying out its primary science mission. However, the satellite provides a unique opportunity for students and engineers to test their designs for mission software.

The Tomographic Experiment using Radiative Recombinative Ionospheric EUV and Radio Sources (TERRIERS) satellite was launched May 18, 1999. Its mission was to produce unprecedented three-dimensional images of Earth's upper atmosphere on a global scale using a unique combination of space- and ground-based instruments.

NASA Chief Scientist Kathy Olsen visits Goddard for a look at facilities and briefings on current projects.

Researchers at Wallops Flight Facility tested this pumpkin-shaped balloon to carry science experiments for up to 100 days. A successful test flight from Ft. Sumner, N.M., used this balloon. Once inflated it is about half the size of a football field.

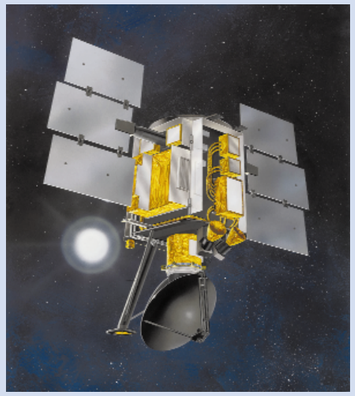
Following its successful launch into space, the satellite has been orbiting Earth as planned, but has been unable to orient itself so that its solar panel fully faces the Sun. The panel is designed to gather solar energy and continually recharge a set of batteries that run the craft and all of its instruments. The spacecraft failed to acquire the Sun, losing its battery power about 10 hours into the mission.

Confident that TERRIERS is basically healthy, researchers from Boston University and Goddard believe that the error can be corrected if they can communicate with the spacecraft. If TERRIERS can be contacted and reoriented towards the Sun, researchers hope to achieve all science and educational goals for this mission.

Finally, the Far Ultraviolet Spectroscopic Explorer, an astronomy mission launched on June 24, explores the universe using the technique of high-resolution spectroscopy in the far-ultraviolet spectral region. The Johns Hopkins University, Baltimore, Md., led the development and now operates the mission in collaboration with the University of Colorado at Boulder, the University of California at Berkeley, the Canadian Space Agency, the French Space Agency, and corporate sponsors.

The outlook for future missions in space sciences is excellent. The Next Generation Space Telescope advance studies are underway and other missions are meeting competitive criteria for final selections.

With the successful launch of the Far Ultraviolet Spectroscopic Explorer, scientists will gain insight into the structure of the Milky Way.



The SeaWinds instrument on the QuickSCAT satellite is a "quick recovery" mission to fill the gap created by the loss of data from the NASA Scatterometer lost in June 1997.

The Goddard Space Flight Center established a new road map, called "Mission 2000," for the direction of its Wallops Flight Facility in Virginia in 1997. In only two years the facility has instituted the major components of this three-year plan to revitalize the work at this 54-year-old research range. It has privatized its satellite and rocket-tracking activities and the sounding rocket operations. New work arriving at Wallops includes the space shuttle small payloads Get-Away-Specials and Space Experiment Modules and management of programs for university small satellites for space and Earth science. With 2000 approaching, the employees have initiated an effort to develop strategic and business plans towards 2005 and beyond.

Dr. Ed Weiler, NASA's Associate Administrator for Space Science, speaks to Goddard audience on the achievements and challenges of the Space Science Enterprise during Center Anniversary events.

"Throughout the past year, Flight Projects continued to provide management expertise needed for the Center to meet its commitments to NASA Headquarters, and specifically to the Earth and space science communities."

James Moore, Director
Flight Programs and Project Directorate

Scientific & Technological Leadership

Goddard Space Flight Center maintains a leading position in space and Earth science endeavors buoyed by a robust technological program.

From astronomy to planetary geology, from biodiversity to oceanography, researchers use data from spacecraft to tell us new things about the universe and the Earth.

These highlights from 1999 demonstrate Goddard's continued dedication to scientific excellence.

Space Science Highlights

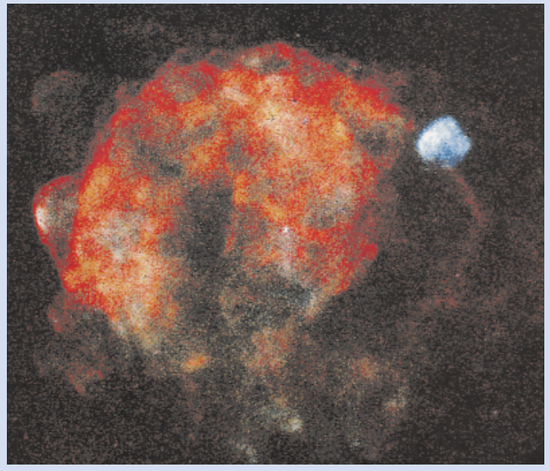
X-Ray and Gamma-Ray Astronomy Illuminates Black Holes

As one X-ray observatory completed its mission, others continued to produce new knowledge.

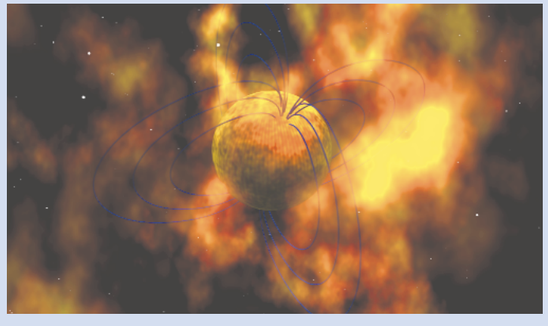
The Roentgen Satellite (ROSAT) completed its observational programs in December 1998. Launched in June 1990, this German/U.S./U.K. satellite performed long beyond its expected lifetime and surpassed scientific expectations. ROSAT detected more than 150,000 celestial X-ray sources, about 20 times more than were previously known. Currently, it is estimated that at least one scientific paper based on data from this satellite is published every day. These findings contributed to our understanding of the mysterious dark matter that pervades the universe, yet defies direct detection, and helped astronomers to an improved appreciation of the manner in which clusters of galaxies form, among many other subjects. ROSAT even detected X-rays from the Moon for the first time. The Goddard Space Flight Center is the U.S. center for ROSAT data analysis, archiving and distribution. It is likely that new findings will emerge from the archive of ROSAT data for years to come.

Observations from another spacecraft, Goddard's Rossi X-ray Timing Explorer (RXTE), detected the presence of what may be one of the strongest magnetic fields in the known universe and thereby confirmed the existence of a previously suspected class of cosmic objects, called magnetars. After an orbiting Russian sensor detected an extremely strong burst of gamma rays from the direction of constellation Aquila on August 27, 1999, Japan's Advanced Satellite for Cosmology and Astrophysics (ASCA) found that X-rays from the same source were pulsating every 5 seconds. Then RXTE swung into action, making crucial diagnostic measurements of the pulsing X-rays. These measurements revealed that the bursting star has a magnetic field at least 400 trillion times stronger than the magnetic field on Earth, and perhaps as much as 1600 trillion times stronger. This doubled the number of known objects with such extreme properties, thereby confirming the theory of magnetars. Remarkably, although the Aquila magnetar is hundreds or thousands of light-years from the Earth, it sprayed enough energy on our planet to modify temporarily the structure and electrical state of a high-altitude layer in the atmosphere.

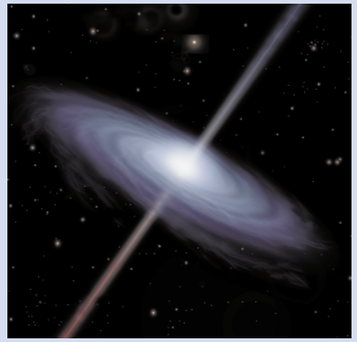
Many studies contributed to a more comprehensive knowledge of black holes, regions in space where the gravity is so powerful that nothing — not even a ray of light — can escape from within.



Two supernova remnants are seen in this X-ray image taken by the ROSAT spacecraft: the larger Vela, which covers most of the field, and Puppis A, enhanced in blue.



This artwork depicts magnetic fields from a bursting star in the Aquila constellation. Observations with GSFC's Rossi X-ray Timing Explorer detected the presence of what may be one of the strongest magnetic fields in the known universe and thereby confirmed the existence of a previously suspected class of cosmic objects called magnetars.



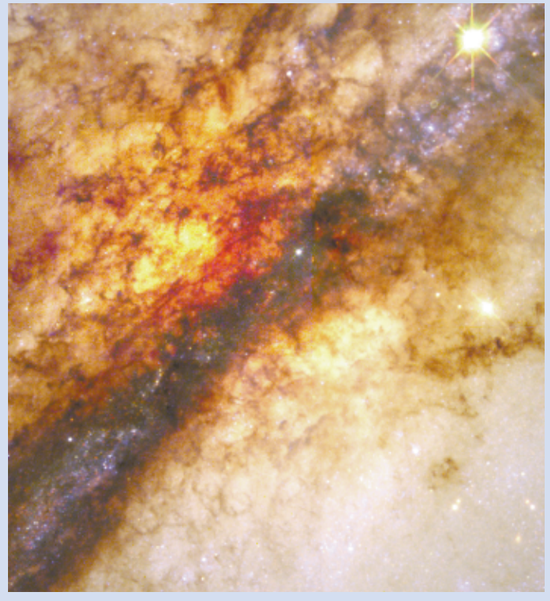
This is an artist's conception of an intermediate-sized black hole. Black holes exist in the heart of large galaxies throughout the universe. Black holes emit no light. What is visible from Earth is the accretion disk (matter swirling into the black hole, often glowing brightly in X-rays) and jets (beams of charged particles moving away from the black hole). An intermediate-sized black hole is 100 to 10,000 times as massive as the Sun yet occupies a region smaller than the Moon. Previously, only two types of black holes were thought to exist: stellar-mass black holes, several times as massive as the Sun, and supermassive black holes, with the mass of a million or billion Suns.

Goddard scientists detected what was hailed as perhaps the first direct detection of matter falling into a black hole. The observations were made with Japan's Advanced Satellite for Cosmology and Astrophysics. The observers found that gas was pouring into a giant black hole at the center of galaxy NGC 3516 at a speed of six-and-one-half million miles per hour. The galaxy is about 100 million light-years from the Earth, where a light-year is a distance of about 5.9 trillion miles. The actual "signature" of the doomed matter consisted of X-rays emitted by atoms of iron in the gaseous state, at a temperature of millions of degrees Fahrenheit.

Goddard's Energetic Gamma-Ray Experiment Telescope (EGRET) on the Compton Gamma Ray Observatory surveyed the highest energy gamma rays currently observable from satellites. The EGRET investigators found that gamma rays coming from beyond our own Milky Way arise exclusively in so called "blazars," where a jet of energy from the vicinity of a giant black hole points almost directly at the Earth. Blazars are found at the centers of very distant galaxies. This conclusion had to be modified in 1999 when further work with EGRET revealed that the nearest galaxy with an active nucleus, meaning a galaxy manifesting evidence of energy release from the surroundings of a central giant black hole, Centaurus A, is also an emitter of very high energy gamma rays. But Centaurus A is not a blazar, because its jets point off in random directions, not toward the Earth. This discovery implies that the high-energy gamma rays can be released from the vicinity of a black hole in a previously unknown manner, as well as in directed beams or jets.

What might be a whole new class of black holes was reported by two independent groups of astrophysicists in April 1999. Called "intermediate-mass black holes," these objects are much larger and more massive than the "stellar-mass black holes" that result from the collapse of a massive star in a supernova explosion. And, they are much smaller and less massive than the "supermassive black holes" that have been found at the centers of galaxies. Goddard scientists turned up evidence for the new class of black holes while studying observations of 39 galaxies made with ASCA and ROSAT, while investigators from the University of Pittsburgh reached a similar conclusion by studying the X-rays from the bright nearby galaxy Messier 82.

The new kind of black holes have masses in the range of 100 to 10,000 times the mass of the Sun. In contrast, stellar-mass black holes discovered thus far have masses that are at least 3 times the solar mass and much less than 100 solar masses, while supermassive black holes are in the range of several hundreds of thousands to several billion times the solar mass. Each type of black hole may originate in a different way.



A Hubble Wide Field and Planetary Camera–2 close-up of the center of Centaurus A. GSFC's Energetic Gamma-Ray Experiment Telescope on the Compton Gamma Ray Observatory revealed that the nearest galaxy with an active nucleus (meaning a galaxy manifesting evidence of energy release from the surroundings of a central giant black hole), Centaurus A, is also an emitter of very high-energy gamma rays. The discovery implies that the high-energy gamma rays can be released from the vicinity of a black hole in a previously unknown manner.

"The Space Sciences had a banner year. There were striking discoveries in multiple fields, from X-ray astronomy to planetary science, and the research revealed new aspects of how the Sun affects our planet Earth."

Dr. Stephen S. Holt, Director
Space Sciences

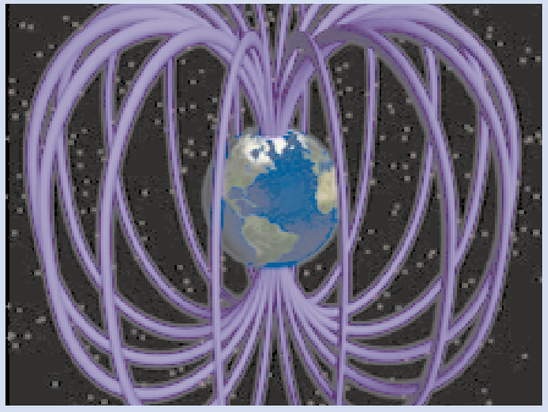
New Findings on the Planets

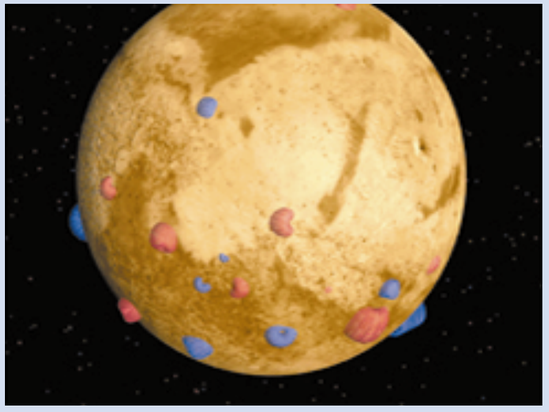
One of the most remarkable discoveries ever reported on the planet Mars was accomplished with Goddard's Magnetometer on NASA's Mars Global Surveyor (MGS). Long parallel bands of magnetized rock were found on the Martian surface. Adjacent bands, called "magnetic stripes," have opposite magnetic polarities. In other words, a compass needle carried on the surface of Mars would point in opposite directions as the carrier moved from one stripe to the next. This remarkable phenomenon represents "fossil" magnetic fields that were frozen into the Martian surface as the crustal rocks solidified. This is reminiscent of parallel magnetic stripes found on Earth which are regarded as the strongest evidence for the occurrence of continental drift "plate tectonics" on Earth. But the Martian stripes differ in several ways, including their magnetic field strengths, which are much greater than the stripes on Earth. The new discovery strongly suggests that Mars once had a global magnetic field that periodically reverses in direction, just as the Earth has now. Presumably Mars' magnetic field died out billions of years ago as its molten iron core cooled and solidified, so that no more magnetism could be generated. Mars cooled much faster than Earth because it is much smaller. Eventually the Earth's core, too, will cool and solidify.

Scientists discovered an unusual type of snowfall on Mars. Using the MGS's Thermal Emission Spectrometer, an instrument developed at Arizona State University to sense infrared radiation from the Martian atmosphere, the researchers found that water ice crystals form and then fall toward the surface, while acting as seeds on which dry ice — frozen carbon dioxide — snowflakes also condense. What begins as a haze of water ice crystals ends as falling snow of ordinary and dry ice.

Planetary researchers also concentrated on the large moon Titan, a satellite of the planet Saturn. Titan is the target of the Huygens Probe, which the ongoing Cassini mission is carrying to the Saturn system. A crucial aspect of aiming the Huygens Probe is to take into account the winds on Titan, which will affect the course of the probe as it drops through the Titan atmosphere. This requires knowledge of both the speed of the wind and its direction. The speed will be estimated from data received previously from a Goddard instrument on a Voyager space probe, but the wind direction must be estimated from new measurements. Goddard observations with a special infrared sensor on NASA's Infrared Telescope Facility at Mauna Kea Observatory in Hawaii are providing this information.

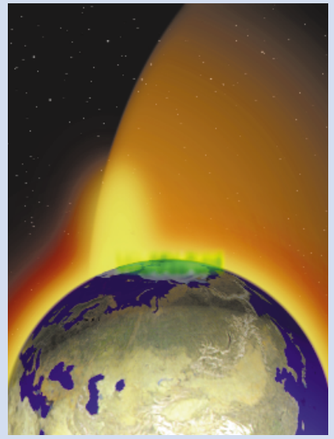
This is an artist's concept comparing the present day magnetic fields on Earth and Mars. Earth's magnetic field is generated by an active dynamo - a hot core of molten metal. The magnetic field surrounds Earth and is considered global (left image). The various Martian magnetic fields do not encompass the entire planet and are local (right image). The Martian dynamo is extinct, and its magnetic fields are "fossil" remnants of its ancient, global magnetic field.





Many Research Findings Bore Directly on how the Sun and its Disturbances Affect our Environment on the Earth

Scientists working with the Center's POLAR spacecraft documented a newly recognized phenomenon: the ejection of large amounts of oxygen from the upper atmosphere of the Earth because of the impact of massive clouds of electrified and magnetized gas that erupt from the Sun. In one specific case, a solar cloud that struck on September 22, 1998, ejected a few hundred tons of Earth's atmosphere. Scientists estimated that on that occasion, the Earth lost about as much atmosphere as the amount of oxygen normally present in the Louisiana Superdome. "We now have direct, quantifiable evidence that disturbances in the solar wind produce changes in the flow of ions out of the ionosphere," the research leader concluded. Ions are atoms and molecules that have each lost one or more of their electrons, so that they become electrically charged.



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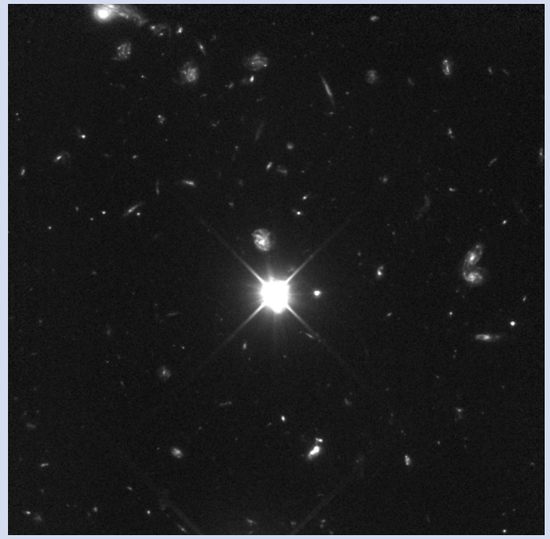
Researchers working with the Geotail spacecraft, a collaborative project of Japan's Institute of Space and Astronautical Science and NASA, and part of the GSFC-managed International Solar Terrestrial Physics Program, found the long-sought location where energy from solar disturbances enters the Earth's magnetosphere to power geomagnetic storms and substorms. These storms and substorms have many effects on society, including disturbances to power grids, pipelines, communications, and orbiting satellites. The entry point for energy carried in disturbances in the solar wind, an electrified gas streaming out in all directions from the Sun, was found to be on the night side of the Earth, at a distance of 12 1/2 times the diameter of the Earth in the direction opposite the Sun, and located in the geotail, an extended region of the Earth's magnetic field that reaches far into space.

The above "entry point" is where magnetic reconnection, a kind of short circuit between the magnetic field of the Earth and a magnetic field traveling in the solar wind, occurs. During this reconnection process, bursts of fast-moving electrified gas fly back up the geotail toward the Earth, triggering the geomagnetic storms and substorms, while other such blobs, called plasmoids, fly out the tail toward deep interplanetary space and are lost to Earth forever.

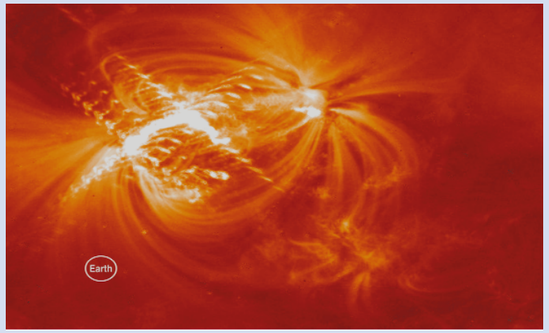
Exploring the Deepest Universe

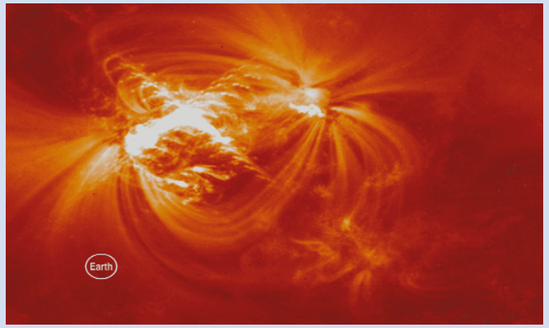
Using three instruments on the Goddard-managed Hubble Space Telescope, astronomers recorded the Hubble Deep Field-South, a penetrating view into the very distant and early universe. The deepest picture of all, extending to dimmer objects in space (rated at 30th magnitude, where the human eye sees readily only to 6th magnitude) than ever photographed before, was obtained in the imaging mode of Goddard's Space Telescope Imaging Spectrograph (STIS), in a total of 156,000 seconds of exposure time. Counting the faint galaxies in the image from STIS, and extrapolating to the whole sky visible from Earth, astronomers concluded that there are about 150 billion galaxies within range of present technology. Each galaxy is a so-called "island universe" of billions or even hundreds of billions of stars.

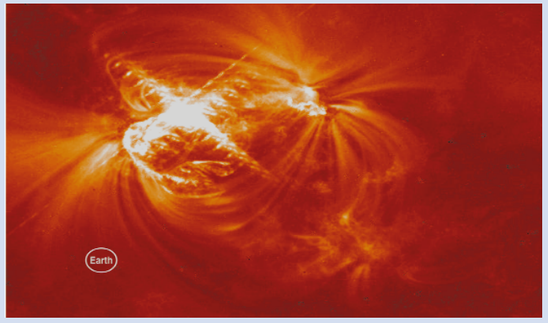
Hubble Space Telescope's exquisite resolution has allowed astronomers to resolve for the first time hot blue stars deep inside an elliptical galaxy. The swarm of nearly 8,000 blue stars resembles a blizzard of snowflakes near the core (lower right) of the neighboring galaxy M32 located 2.5 million light-years away in the constellation Andromeda.



The deepest visible/ultraviolet light image of the universe ever taken, revealing galaxies down to the 30th magnitude, using the Hubble Space Telescope.







Sharply revealed, loops of hot gas in the solar corona were captured in this image from TRACE. The small circle at lower left represents the size of the Earth to the same scale.

Sharpest Pictures Ever Made of the Solar Corona

The Transition Region and Coronal Explorer (TRACE), a Small Explorer developed by scientists at Stanford Lockheed Institute for Space Research, Smithsonian Astrophysical Observatory, Montana State University and the Goddard Space Flight Center, obtained the highest resolution images ever made of the Sun's outermost and constantly changing atmospheric region, the corona.

TRACE was launched in April 1998, equipped with a telescope to record extreme ultraviolet radiation from the hot gases in the solar corona. Extreme ultraviolet radiation has shorter wavelengths and higher energy than ultraviolet light, but longer wavelengths and lower energy than X-rays.

The sharp images from TRACE enabled the scientists to detect vibrating motions of huge loops of hot gas on the Sun after a blast wave from a solar explosion struck the loops. Unexpectedly, the vibrations were quickly squelched, as though something was "braking" the loops. The braking phenomenon was apparently a property of the hot solar gas, and just as hitting the brakes in a fast-moving car heats them and may burn out the brake linings, the squelching effect or coronal friction may feed heat into the solar atmosphere. This could be the long-sought explanation for why the corona is more than 100 times hotter than the visible surface of the Sun that lays beneath it.

Birth of a Solar System?

Using an occulting device to block most of the energy from the roughly 3-million-year-old star AB Aurigae, scientists observing with the STIS on Hubble Space Telescope found clumps of gas and dust ringing the young star. Researchers suspect that the cloudy matter is starting to accumulate in a process that may form new planets over the course of the next few million years. AB Aurigae is about 2.4 times more massive than the Sun and is an estimated 470 light-years from Earth.

Supernova in the Making?

Goddard scientists and co-workers using the Hubble Space Telescope Imaging Spectograph to monitor and explore the supergiant star Eta Carinae found that it had doubled in brightness since early 1998 and now shines more brilliantly than it has in a century. Hubble images show a spectacular twin-lobed structure around this star, due to past ejections of huge amounts of matter. The scientists suspect that we may be witnessing the start of another massive eruption, and note that a catastrophic destruction of the entire star, called a supernova explosion, could in theory occur at any time.

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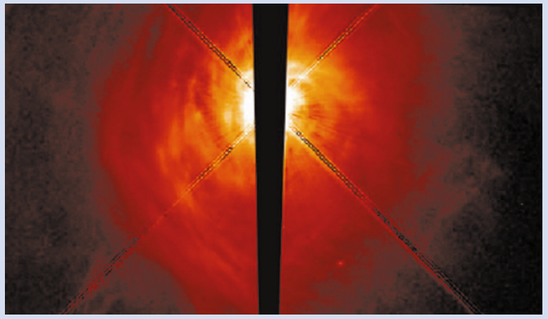

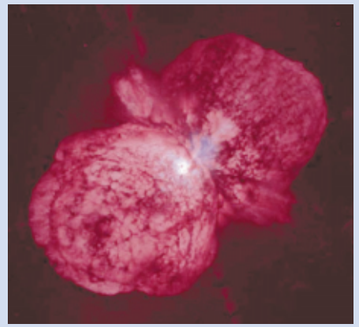

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The space science organization at Goddard is looking forward to an exciting and challenging era with the completion of on-orbit servicing of the Hubble Space Telescope and the development and implementation of Explorer missions to learn more about the universe.

Lunar Prospector

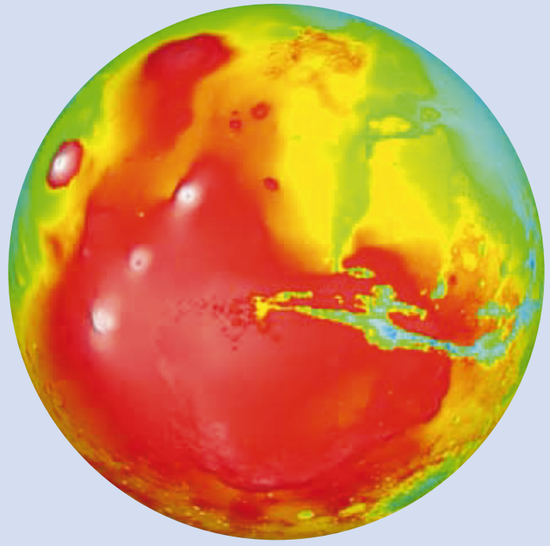
The Lunar Prospector mission made striking discoveries about the Moon's magnetic fields, including evidence that the strongest lunar magnetic fields formed as a result of giant impacts which occurred about 4 billion years ago. Goddard was a co-investigator on Lunar Prospector's magnetometer instrument. Lunar Prospector was launched from Cape Canaveral on January 6, 1998, and collected orbital mapping data on the entire Moon from January 11, 1998, through the end of July. The mission ended on July 31 when flight dynamics controllers at Goddard guided the Lunar Prospector to a designated crash site inside a crater near the south pole of the Moon. As with the primary and extended mission, Goddard provided the trajectory design, maneuver generation, and navigation for this event.

Studies of Mars

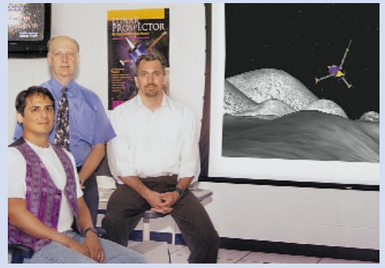
Exploring Mars with satellites in orbit around that planet will help us understand not only Mars, but also our own planet.

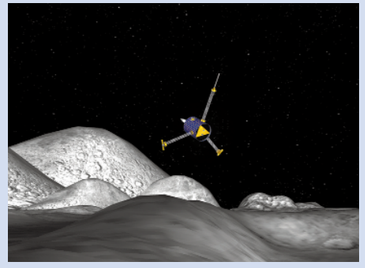
For the first time, the global landscape of Mars has been accurately measured. The GSFC Mars Orbiter Laser Altimeter on the Mars

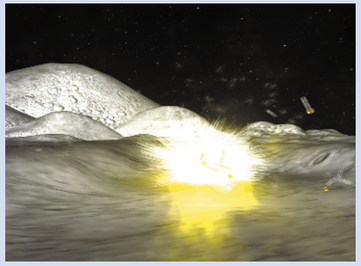
This image, the first global 3-D view of Mars, reveals a deep basin and pathways for water flow. White spots are volcanoes.



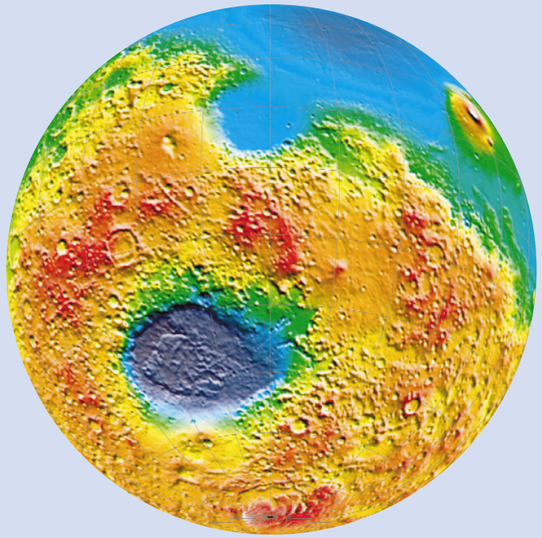
Shown here is the Goddard guidance control team that guided the Lunar Prospector.







These images are from a computer animation illustrating the impact of the Lunar Prospector spacecraft with a crater near the south pole of the Moon.



This image from the Mars Orbiter Laser Altimeter shows high elevations as reds and whites, low elevations in blues. The prominent hole was caused by an asteroid impact early in Mars' history.

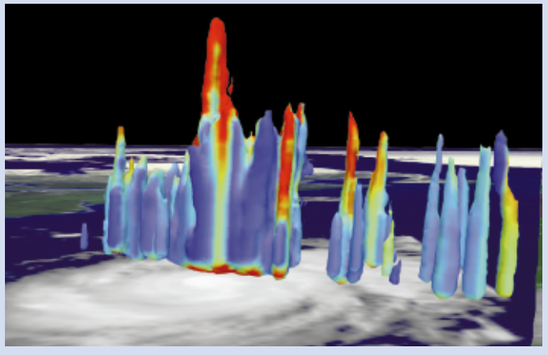
Global Surveyor spacecraft has collected more than 150 million height measurements with an accuracy of several feet. Here are some samples of new results from Goddard-derived technologies and investigations: The distance from the lowest depth to the highest point on Mars is the largest known distance of any of the inner planets. Estimates of the volume of water ice in the Martian polar caps suggest they hold less water than once flowed through the now-dry channels. Martian channels appear to extend further into the lowlands than previously recognized in image data. And a large number of large, nearly buried impact basins not readily visible in images suggests the early history of Mars was far more violent than previously thought.

Observations of the orbit of spacecraft around Mars have produced a new, more precise knowledge of its gravity field. This provides information about the internal constitution of the planet. It has shown, for example, that the crust is thinner and stronger in the southern hemisphere, than in the northern. New knowledge of the gravity field is essential for accurately calculating the position of spacecraft in orbit about Mars.

Earth Science Highlights

During 1999, the Earth sciences organization at Goddard made significant progress to improve our understanding of how the atmosphere, land and oceans behave like a system. We moved closer to an ambitious objective of making more accurate and proactive environmental predictions. Recent successes in measuring and modeling rainfall patterns and biological properties of the land surface as well as important ocean studies became the building blocks towards more precise 14-day weather predictions and projections of biosphere changes. We made progress in our ability to predict global air and water quality by using advanced measurements of atmospheric ozone and other compounds as well as applying state-of-the-art ocean studies. Lastly, our ability to predict natural hazards and severe storms is enhanced by our increased understanding of planetary dynamics, climate change and global modeling. We continue to build on the substantial foundation of previous work with a clear eye to the future, to a time when our Nation can reap the substantial economic benefits of more accurate environmental prediction.

This is a computer-enhanced image of Hurricane Bonnie showing a cumulonimbus storm cloud, towering like a skyscraper, 59,000 feet into the sky from the eyewall. This image was obtained by the world's first spaceborne rain radar on board the TRMM spacecraft on August 22, 1998.

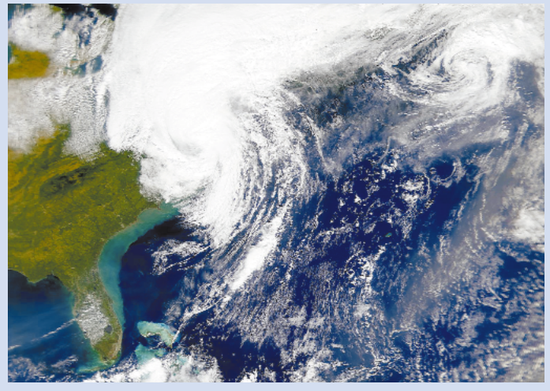


Precipitation Studies

The amount of rain that falls changes from year to year, making forecasts and plans difficult for crop management, or to protect people and property from floods or droughts. Yet, researchers believe that understanding rainfall measurements, particularly in the tropical regions, is critical to an appreciation of rainfall impact to local regions.

The Tropical Rainfall Measuring Mission (TRMM), launched in 1997, provides new insight into how and where rainfall occurs during El Niño and La Niña events. These extreme weather patterns, which occur every three to five years, have far-reaching effects on people and property. In addition, incorporation of these data into our global predictive models improves the model's predictive capability. These models help predict how changes in temperature in the tropical regions of our planet affect rainfall patterns around the world. This demonstrates how satellite data can be used to help predict when and where floods, droughts, and other extreme weather patterns will occur, and can be used to help protect property and lives.

This work makes use of the notion of a multi-model super-ensemble recently developed at GSFC for the improvement of seasonal climate, global weather, and hurricane track and intensity forecasts. While still in the testing phases of the project, this forecast model did correctly forecast the track of Hurricanes Dennis and Floyd up the eastern coast of the United States with an eventual landfall in North Carolina. As with any new model, however, confidence grows with each correct forecast and the TRMM program is keeping careful statistics on the success of this model in the current testing phase.



Atmospheric Ozone Research

There is a natural shield protecting life on our planet: the ozone layer. Without this layer of gas in our upper atmosphere, life on our planet would not have developed as we know it today. Like any shield, it must be maintained to continue its protective role. Damage to the ozone layer translates to danger for the Earth.

One of the ways that people may change the protective ozone layer is by using chemicals with chlorine in them, especially chlorofluorocarbons, or CFC's. The breakdown of CFC's in the stratosphere releases chlorine, causing stratospheric ozone loss. These chlorine-induced ozone losses are most evident in the Antarctic ozone hole. When these chemicals travel to the stratosphere, they are harmful to that layer. When chlorine in the stratosphere increases, levels of ozone go down, and the levels of UV rays at the Earth's surface increase. Increased levels of UV can lead to harmful health effects, such as blindness because of cataracts and increases in skin cancer.

Anne Thompson, a Goddard atmospheric scientist and mission scientist for the Subsonic Assessment Ozone and Nitrogen Oxides Experiment (SONEX), part of NASA's Atmospheric Effects of Aviation Experiment, studies ozone chemistry across jet line pathways.

Goddard scientists lead investigations concerning the health of the protective ozone layer. This research includes exploring the ways that human activities impact the chemistry of the atmosphere generally, and specifically the presence and

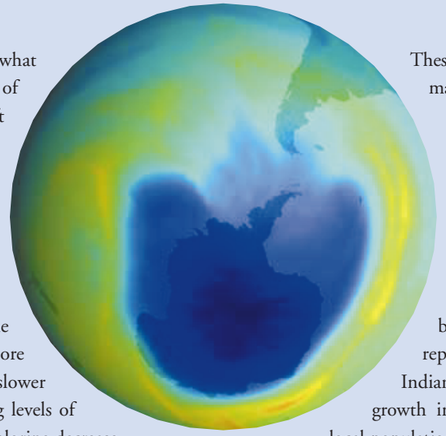
Hurricane Floyd

On September 16, 1999, SeaWiFS captured this image of Hurricane Floyd as it passed over North Carolina and the Chesapeake Bay region. The storm produced increased activity in coastal waters, which churned up sediments from the shelf floor. This allowed the SeaWiFS instrument to image the boundaries of the continental shelf, something which had never been done this way before. The sediment-laden waters, which indicate the location of the continental shelf, show up as light blue or turquoise. The clearer, deep ocean waters appear dark blue.

Aftermath of Hurricane Floyd

This SeaWiFS image, collected on September 23, 1999, shows the after-effects of Hurricane Floyd. Increased rainfall resulted in greater run-off from rivers, which introduced large quantities of suspended sediments, and in some cases sewage, into the estuary systems of the Cape Hatteras area. These contaminated estuaries show up as dark brown in this image.

A NASA satellite has shown that the area of ozone depletion over the Antarctic is a bit less in 1999 than it was the year before.



location of ozone. These activities include what may be the possible effects of a fleet of planned subsonic and supersonic aircraft on this layer.

Following up on recent observations by Langley scientists that the amount of chlorine in the upper atmosphere has stopped increasing, Goddard scientists have used mathematical computer models to predict that the dependent global ozone levels will continue to recover, although more slowly than originally thought. This slower recovery is probably because of increasing levels of other atmospheric chemicals. The slight chlorine decrease is most probably a result of curtailment of CFC production.

The effects of CFC's on stratospheric ozone have been particularly clear over Antarctica where, for years, a huge "ozone hole" has developed early in the Antarctic spring. This region of lower-than-normal ozone levels in the stratosphere has been increasing yearly for well over a decade. Recent Total Ozone Mapping Spectrometer data, analyzed by Goddard scientists, show that the size and depth of the ozone "hole" in the Antarctic region has leveled out. A similar but smaller ozone depression in the Arctic region was observed in 1997, but has not reappeared because of the warm and active winter stratospheric weather in the last two years. Goddard scientists will continue to explore this, because the variations of the Arctic stratospheric weather patterns are not fully understood.

Land Surface Studies

Goddard scientists are at the forefront of new and improved information about land surface phenomena.

The successful launch of the Landsat-7 mission on April 15, 1999, represents a major step forward in our investigation of the Earth's land surface. The satellite, operated under the joint leadership of NASA's Goddard Space Flight Center and the U.S. Geological Survey, shows early results of image quality perhaps better than expected. A key feature of the new Landsat program is the decrease in costs for images: the cost of a scene is only $600, almost $4000 less than prices for Landsat-4 and -5 data. This will make the data more easily accessible to a wider range of users. Also, there is no copyright protection of Landsat-7 data. Once purchased, scenes may be copied and redistributed without restriction. These changes will enhance the use of these data in primary and secondary school classrooms because more curriculum developers can now afford to purchase them and, once displayed in the classroom, they can be freely redistributed in any form. These scenes are used to teach science, mathematics, and geography.

Using satellite observations to examine environmental conditions that demonstrate a favorable nature for the spread of disease is a new and promising area of research. Recent work gives researchers the ability to forecast outbreaks of Rift Valley Fever in Kenya two to five months before they occur. This work — based upon repeatable patterns of Pacific Ocean and Indian Ocean sea surface temperature and plant growth indices — provides enough lead-time for local populations, organizations and businesses to prepare for and minimize the effects of such outbreaks.

Studies of land-based phenomena carried out on the ground show how Amazonian forests are being cleared at unprecedented rates. This is expected to incur major environmental consequences on a regional to global scale, with effects on local weather, agriculture and biodiversity. A joint agreement was signed in December 1998 by government officials of the U.S. and Brazil to develop eight regional study sites in the Amazon. The sites are outfitted to enable continuous, detailed ecological studies for the next five years. Goddard field investigations as well as remote sensing measurements began this year.

Landsat-7 scene, May 28, 1999, that shows Baltimore, Washington, D.C., Annapolis, and the northern reaches of the Chesapeake Bay. Note the sediment in the bay and the contrast between the urban areas (gray) and vegetation (green). This is among Landsat-7's first scenes of this region.

Preparing Landsat-7 at Valley Forge, Pa., for delivery to the launch pad at Vandenberg AFB in California.

Ocean Studies

Approximately two-thirds of the Earth's surface is covered by water. Because approximately 50 percent of the world's population live in the coastal zone, understanding and monitoring the changing ocean is critical. For example, a decline in the health of fisheries can impact communities that depend on them for their food and livelihood. Changes in sea level can also impact human lives and property along the coastlines.

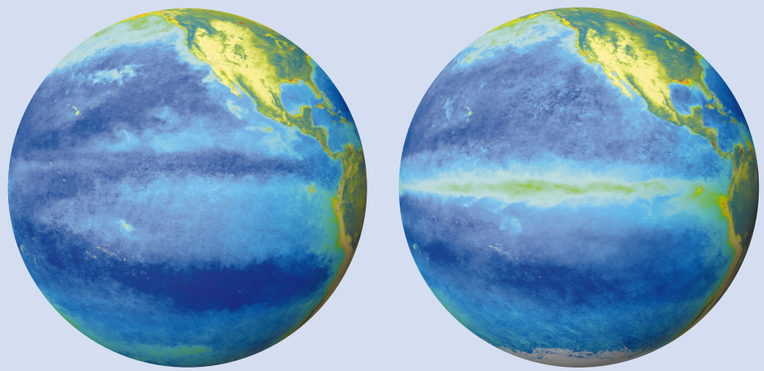
During 1999, Goddard scientists studied the details of how energy in several forms moves between the atmosphere and oceans. These transfers affect the timing and strength of El Niño events and the subsequent La Niña. The appearance of tropical cyclones on the continental U.S. points to the importance of understanding these events from economic and human perspectives. In addition, Goddard researchers applied computer-based mathematical models to study ways in which the Indian Ocean may play a role in generating El Niño and La Niña events.

The nature of ocean events and the health of the oceans can be measured by looking at changes in ocean color, most notably those colors present in plants. These colors often come from chlorophyll, a pigment used by organisms to convert sunlight into useful biological energy. In 1999, the SeaWiFS instrument obtained the first global view of the marine biosphere over an entire year. Other work showed that the high-accuracy measurements, which are essential to identify month-to-month and year-to-year changes in the ocean biosphere, are routinely possible in the harsh marine environment. SeaWiFS data assisted in monitoring the development and movement of tropical storms and hurricanes, such as Dennis and Floyd, and contributed to decisions by local officials to evacuate coastal properties.

Other techniques, such as very low-power lasers that penetrate the water and measure the health of living coral reefs, monitor the health of the oceans. Coral reefs are the marine equivalent to tropical rain forests and like rain forests they are now being subjected to increasing stress. In fact, coral reefs worldwide are mysteriously dying. Because these reefs help stabilize coastlines, their health has a major impact on the economic well-being of coastal communities.

The Earth's massive ice sheets contain most of the fresh water available on our planet. Changes in ice sheet behavior can affect the half of the world's population that lives in the coastal zone. Goddard scientists are increasing their understanding of how ice flows grow and shrink by using several light- and radar-based techniques. Information gathered in 1999, along with new maps of surface features — never before seen in such detail — allow Goddard scientists to understand how ice has behaved in the past and how it may behave in the future. These new data are used in computer-based mathematical models to predict future ice-sheet flow changes and their effects on sea level.

SeaWiFS captured the 1997–1998 El Niño event. During the winter, abnormally warm conditions in the equatorial Pacific Ocean produced a reduction in plant nutrients, essentially starving the entire ecosystem. As conditions returned to normal, an increase of plant nutrients caused the concentration of chlorophyll, which shows up as bright green in the July image, to increase significantly.



Landsat-7 scene, September 23, 1999, of coastal North Carolina depicting the after-effects of Hurricanes Floyd and Irene. The Pamlico River swells far past its banks and the massive flow of sedimentation and waste run off into Albemarle Sound. The light-colored strip on the right side is the Outer Banks.

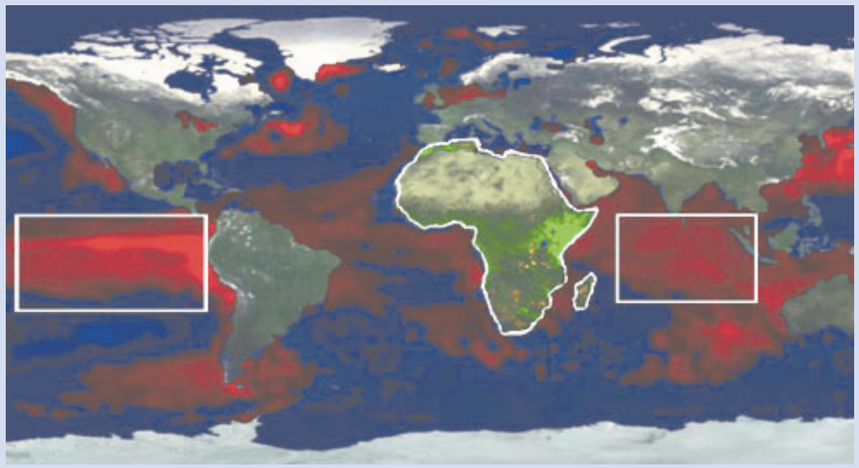
Climate Change, Modeling, and Prediction

Predictions of global change — global warming in particular — impact people's daily lives. For example, there may be significant economic and social effects from global change on world food production. GSFC scientists are providing critical data to policy and decision makers.

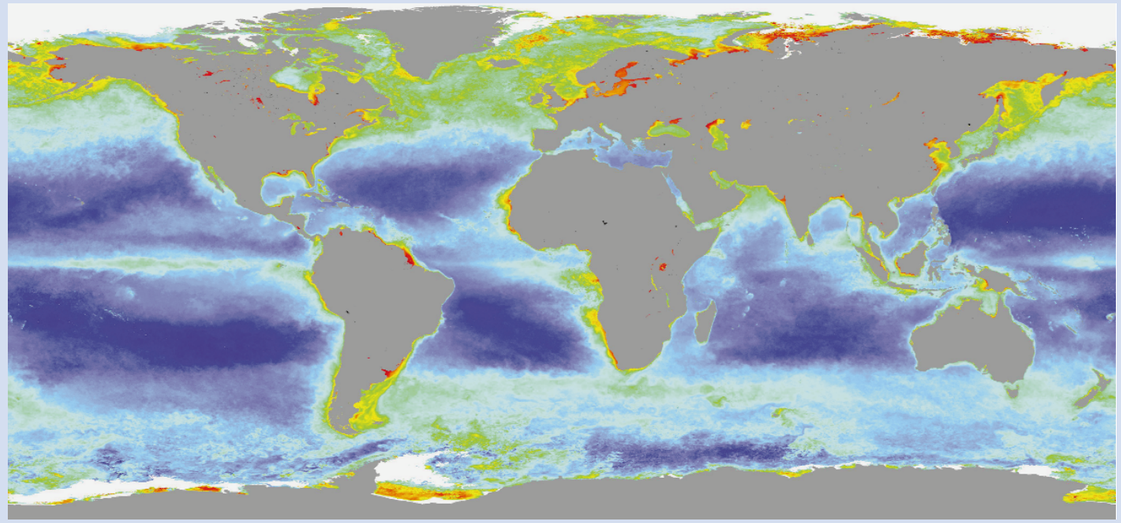
New data show that crop production in developing countries is likely to be more vulnerable to projected climate changes than agricultural production in developed countries. Reliable information on long-term climate change is needed to help evaluate how effective alternative strategies might help us respond appropriately to these changes.

Goddard investigations predicting rainfall estimates and hurricane formation, growth, movement, and shrinkage are proving successful. For example, information from Tropical Rainfall Measurement Mission significantly improved hurricane track predictions. Likewise, the NASA Seasonal to Interannual Prediction Project is developing techniques to use satellite observations of the ocean and land surface to improve predictions of El Niño and its impacts on North America. Scientists at GSFC developed techniques to predict the ways that Asian monsoon-related floods and droughts vary from year to year. Goddard scientists are coming closer to predict floods like those that occurred in 1998, which covered 70 percent of Bangladesh with water. Observations with the Tropical Rainfall Measurement Mission and the use of a regional climate model suggest that the flooding may be linked to a late appearance of the yearly Asian monsoon and increased heat-driven movement of air over the Indian Ocean. Scientists are studying the role the Indian Ocean plays in the El Niño/La Niña events. They now know that the Indian Ocean was in its most perturbed state in over three decades, six months before the very strong 1997 El Niño began.

The use of a new computer-based mathematical climate model may be an important step forward in simulating the ways that climate changes over decades. The model will affect our ability to predict ways that the Earth's surface temperature responds to changes in the Sun's energy output. It may also help us understand what portion of climate change results from natural variations in the Sun's output. Historically, most climate models have concentrated on the lower atmosphere, and have not included the ways that the upper and lower portions of the atmosphere interact. This year, Goddard scientists have included realistic ways of representing energy input from the Sun and how ozone levels and distribution change, and includes a representation of the complete stratosphere.



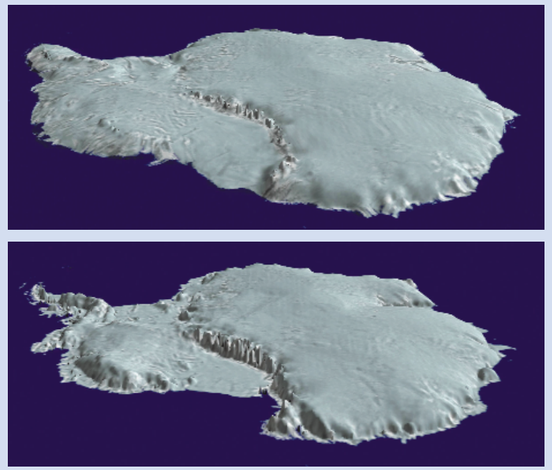
Scientists, using satellite data, discovered that the combination of the warmer than normal water temperatures associated with El Niño and rising sea surface temperatures in the western equatorial Indian Ocean can trigger outbreaks of Rift Valley Fever in East Africa.



This image shows a global composite of data from September 1997–August 1998. The red colors show high concentrations of chlorophyll in the water, the yellows/greens indicate intermediate concentrations of chlorophyll, and the blues/purples show low concentrations of chlorophyll.

Planetary Dynamics

Attempts to understand how the Earth's various systems interact must be supported by basic information about the structure of the Earth. A new Goddard-generated estimate of Earth's gravitational constant — now known to be better than one part per billion — is the most precise value ever obtained. Highly accurate measurements of Earth's gravity are a key to measuring changes in the height of the ocean's surface, which is a key indicator of the magnitude of an El Niño event.



For the first time, researchers generated a computer model depicting changes in the Antarctic ice sheet since the peak of the last ice age, nearly 20,000 years ago. The west Antarctic lost nearly two-thirds of its mass during this period.

Goddard scientists are exploring parts of the Earth's environment that extend into space. Preliminary results from the Oersted Magnetic Field Satellite indicate that the Earth's magnetic field has decreased significantly since it was last measured in 1979 and 1980. High-energy particles, traveling along this "highway" of constantly changing magnetic fields, are responsible for significant damage to orbiting satellites by upsetting and degrading satellite electronics.

Goddard's role, to examine, study and offer interpretation and data related to the Earth, enables researchers, educators, students and many industries to apply new knowledge to improve the quality of life as we know it.

Dr. Ghassem Asrar, NASA's Associate Administrator for Earth Science, addresses the Goddard community on the Center's high-profile missions contributing to increased knowledge about the Earth.

Technologies

Significant scientific results rise from the translation of data, which come from sophisticated spacecraft. These spacecraft not only carry unique instruments, but also, as vehicles, must survive the unforgiving environment of space.

Goddard's talented work force applies emerging technologies to build devices that are the core of spacecraft that meet the needs of delivering measurements and other data from Earth's orbit. To accomplish this, the Center's engineering capabilities are organized around mechanical systems, electrical systems, instrument technology, guidance, navigation and control, and finally, information systems. During the past year, exciting breakthroughs in coatings, electronics, data processing and optics, as well as innovative packaging of hardware to save space and weight, became a part of Goddard's innovative technologies portfolio.

Recent highlights of advanced engineering practices include:

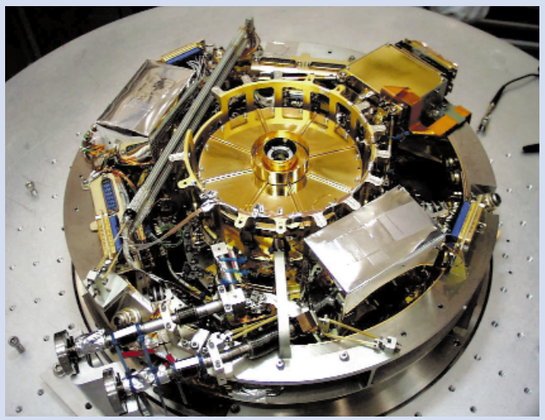
- unique coatings on spacecraft that are intelligent enough to know when to shed onboard heat if the space environment requires a specific range of temperatures for instruments or surrounding components to continue to operate;
- new electronics that operate at 1/4 volt rather than the typical 5 volts, representing a 20:1 reduction. This reduction results in smaller sizes, weights and costs, benefiting the entire electrical assembly of a spacecraft;

"The Information Science and Technology community will be critical to leading the Goddard Space Flight Center into the next century by revolutionizing the capture, delivery and transformation of space data and systems into providing deeper understanding for scientists and public alike."

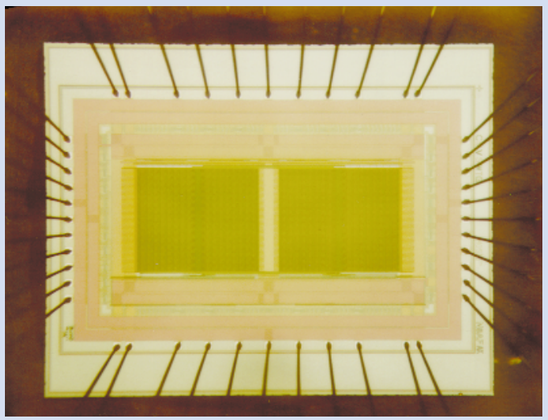
Dr. Milton Halem, Assistant Director
Information Sciences, and Chief Information Officer

- advanced techniques to accelerate data processing for the Earth Observing System, processing nearly a terabyte of data a day using a personal computer with commercial reconfigurable computing cards. This allows images to be placed on websites from orbiting spacecraft within seconds of being processed;
- state-of-the-art optics, segmented to fold inside a launch vehicle, that will enhance engineering efforts to send larger aperture telescopes into space and periodically tune them up to eliminate any negative effects of the telescope deployment or changes from the space environment;
- miniature and lightweight packages for chopper mechanisms that meet high-precision positioning and velocity control with the least amount of power consumption;
- unique devices that permit spacecraft detectors, at already very low temperatures, to get even cooler. These chillier temperatures allow instruments to achieve remarkable sensitivity in orbit. Advanced engineering tools enable a longer life for ultra-sensitive components on board spacecraft.

This view of the X-Ray Spectrometer (XRS) instrument shows the detectors, located just under the circular window. These detectors are cooled to 0.06 of a degree above absolute zero by unique refrigeration several inches below.



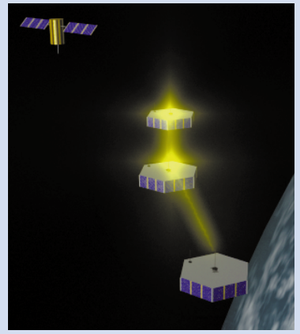
This chip represents a revolutionary new process for fabricating electronics which operates at thresholds approaching 1/4 volt; this represents a 20:1 reduction in power used.



These photographs show NASA's High Resolution X-Ray Spectrometer being lowered into a tank containing solid neon and sealed in preparation for launch. The spectrometer will be installed aboard the Astro-E X-ray satellite for launch in 2000. The instrument was developed jointly by the Institute of Space and Astronautical Science in Japan and Goddard using microcalorimeter detectors originally developed at Goddard.

In addition, numerous examples occurred where Goddard researchers capitalized on their expertise in web-related technology to gain national recognition for communicating science, such as the selection by Science magazine of the science visualization studio as the "cool site" for its stunning images of the flows of Antarctic ice. Other examples include the millions of accesses of the NSSDC "Solar Eclipse" website, the choice by Yahoo of the Applied Information Branch "Global View From Space" as the hot site of the week, and the development by the Information Systems Center of an automated Internet spacecraft maintenance system, "GenSA." These are but a few areas of application that the future holds for information technology.

The unique engineering capabilities at Goddard enable researchers to take on challenges, doing the impossible to build extraordinary innovative spacecraft and enable or enhance unique spacecraft systems or instruments.



Three nano satellites, or nanosats, fly in formation in this artists concept. Goddard, the Air Force Research Laboratory and universities are working together on planning missions, designing spacecraft and developing technologies for small satelite experiments to be conducted through the University Nano-Satellite Program.

"The celebration of 40 years of excellence and incredible contributions to technology and understanding of Earth and the universe, reminded me of how privileged I am to be part of Goddard. Every new challenge ahead of us is an opportunity to paint the canvas of the next 40 years. I can't think of a better place to be!"

Orlando Figueroa, Director
Systems, Technology, and Advanced Concepts (STAAC) Directorate

Project Goddard

The Center's Associate Director led Project Goddard as a result of recommendations made by Goddard supervisors in response to the Center's 1997 Employee Survey. Suggestions focused on the following four initiatives which the supervisory team felt were of top priority to ensure future success of the Center's missions and goals:

- Provide effective, unified leadership by developing unified Center goals, plans and strategies.
- Improve internal communications by including both middle management and employee participation in the communication process, establishing a communications plan for each change initiative and ensuring consistent communication tailored to the audience.
- Develop operational plans for all levels of the organization that link to the Center's Strategic Implementation Plan.
- Align Center resources to core business bases by defining the Center's business processes and business objectives and developing an approach to allocate resources to these core objectives.

The focus of the Project Goddard initiative defines the desired future state of Goddard in 2003 that would fulfill Enterprise strategic plans, as well as develop a transition strategy to get us there. Critical to the initiative was a Centerwide core competency and resource assessment exercise to define the core processes, core competencies and essential services, as well as the skills, facilities and tools needed to achieve its mission. Skills, facilities and tools that exist today were compared to those needed to achieve the 2003 vision. A gap analysis indicated what the Center must do or change to achieve its vision. Outcomes of the gap analysis highlighted the Center's need to:

- revitalize its workforce by replenishing its skills and resolving skill mix issues;
- focus facilities revitalization efforts on our scientific laboratories;
- provide meaningful and sustained in-house work to maintain our core competencies;
- maintain value-centered management practices.

Each Center organization completed a transition plan describing how it will resolve the identified gaps and is now implementing these plans.

As the objectives of the Project Goddard initiative are carried out, attention shifts to a more tactical strategy. Efforts underway look at developing an Integrated Business Plan to align the Center's business processes. This affords the Center information needed to make both strategic and tactical decisions when it is time to make those decisions. Project Goddard launches the Center into the next century with a keen eye on its people, facilities, and approaches necessary to accomplish excellence.

"Project Goddard was a strategic assessment focused on establishing a future vision for Goddard. We are now focusing on our core competencies and positioning the Center to capture meaningful future work."

Mary Kicza, Associate Director
Goddard Space Flight Center

"This has been a year in which we have created new forums for dialogue on equal opportunity and diversity issues. We've clarified roles and responsibilities, generated deeper understanding, and positioned ourselves for significant and sustainable cultural change."

Dillard Menchan, Chief
Equal Opportunity Program Office

Economic Impact

Goddard significantly impacts the local and national economy. As the Center acquires the necessary goods and services to perform its mission, the direct and indirect impacts of the expenditure of these funds affect the economic health and development of the local, state, and national economy. The dollars spent by Goddard enhances business development, creates jobs, and increases the tax base.

Contract Obligations

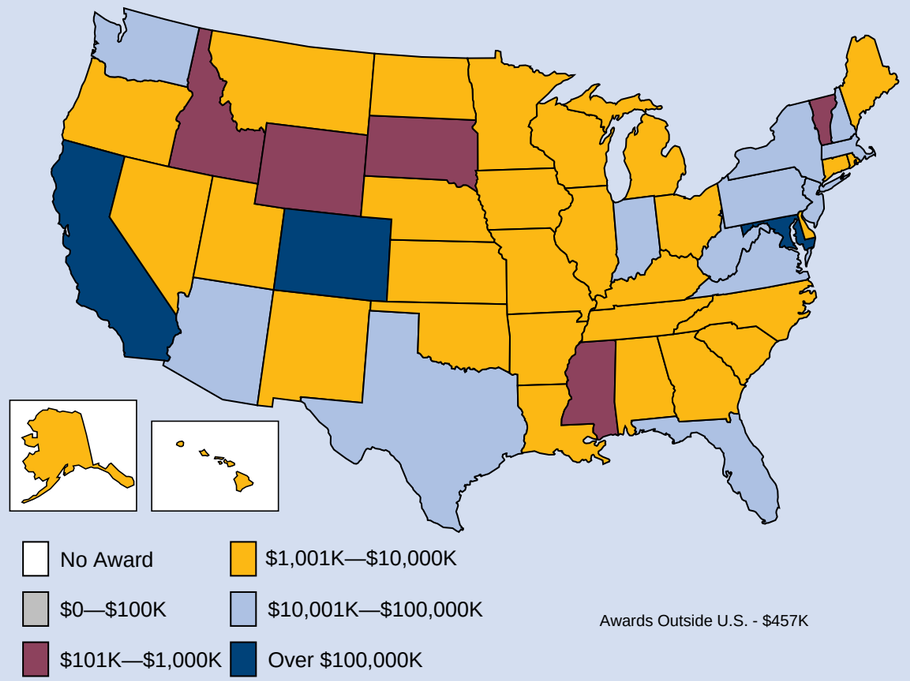
The largest portion of Goddard's budget is obligated through contracts with commercial firms, nonprofit institutions, and other government agencies. These contracts allow the Center to acquire the goods and services necessary to accomplish its mission. Ultimately, these dollars are returned to the local, state, and national economy in the form of gross output, sales, the purchase of intermediate goods and services, and employee income. For every $1 that Goddard obligates, a total of $2.09 in gross output of sales is generated in the state of Maryland alone.

During Fiscal Year (FY) 1999, Goddard processed more than 40 percent of the Agency's contractual actions and 23 percent of the contractual obligations. In total, the Center obligated over $2.3 billion on new and existing contracts during FY 1999. These obligations and prime contract awards are issued to contractors nationwide, as well as outside the United States. Commercial firms received 60 percent, educational institutions 28 percent, nonprofit organizations 8 percent, other government agencies 3 percent, and 1 percent was awarded geographically outside the U.S.

Employment Impact

Each year, Goddard accomplishes its mission through the dedication and support of both civil servant and contractor employees. In FY 1999, Goddard employed over 3,100 civil servants and spent $281 million on their salaries and benefits. Every payroll dollar paid by the Center generates an additional $1.20 of income in the state of Maryland.

Total Prime Contract Awards - FY99

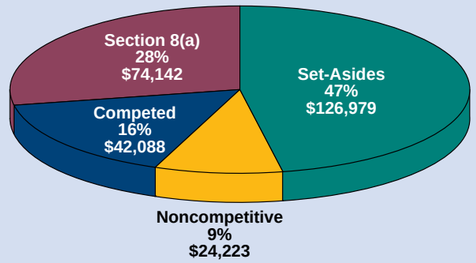


Support to Small and Disadvantaged Businesses

Goddard continues to provide numerous opportunities for small businesses. In FY 1999, the Center obligated $267,432,000 on new and existing contracts with small, disadvantaged, and women-owned businesses. Forty-seven percent of these obligations were set aside exclusively for small businesses and 28 percent were awarded to disadvantaged small businesses in the Small Business Administration's 8(a) program.

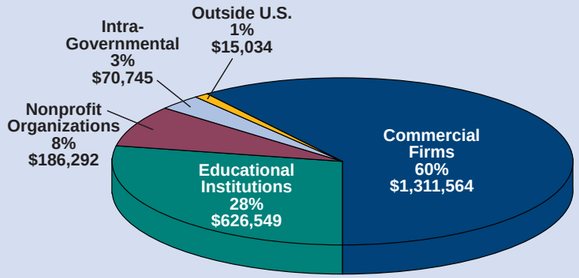
Distribution of Awards to Small and Disadvantaged Business FY99 Obligations

(In Thousands)



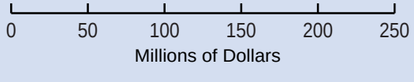
Distribution of Procurements FY99 Obligations

(In Thousands)



Top 25 Business Contractors - FY99

FY 99	FY 98	Company	Number of Contracts	Millions of Dollars Obligated
1	3	Lockheed Martin Corp.	41	$202.9
2	5	Hughes Aircraft Company	5	$173.6
3	6	Hughes Information Technical Corporation	1	$123.2
4	4	TRW, Inc.	7	$121.6
5	2	AlliedSignal Technical Services	9	$62.3
6	9	Raytheon STX Corporation	15	$56.8
7	10	Swales & Associates, Inc.	2	$56.8
8	7	Ball Aerospace & Tech. Corporation	12	$50.5
9	8	ITT Corporation	4	$46.7
10	41	KPMG Peat Marwick LLP	1	$35.4
11	17	Cortez III Service Corporation	1	$26.8
12	18	Computer Sciences Corporation	18	$25.4
13	16	NSI Technology Services Corporation	3	$24.6
14	14	Aerojet General Corporation	2	$24.3
15	12	Space Systems Loral, Inc.	2	$22.6
*16	25	QSS Group, Inc.	4	$22.3
17	23	Fairchild Space & Defense Corp.	2	$20.5
18	98	PRC, Inc.	3	$20.0
19	21	Science Systems Applications	9	$18.7
20	13	Jackson & Tull, Inc.	2	$14.9
21	22	Unisys Corporation	1	$14.7
22	26	CTA, Inc.	1	$14.6
23	23	General Sciences Corporation	5	$13.0
24	24	Brown & Root Services Corporation	1	$11.7
25	11	Santa Barbara Research Corporation	4	$11.6

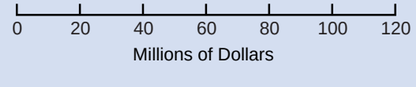


Source: BBD210CX (Format H) Report

*8(a) Minority

Top 25 Nonprofit Institutions - FY99

FY 99	FY 98	Institutions	Number of Contracts	Millions of Dollars Obligated
1	1	Johns Hopkins University	96	$109.4
2	2	Assoc. of Universities for Res. in Astronomy	33	$62.1
3	3	University of Colorado — Boulder	184	$55.4
4	4	University of Maryland — College Park	168	$33.2
5	5	University of California — Berkeley	98	$31.9
6	8	California Institute of Technology	77	$30.9
7	19	University of California — San Diego	88	$24.7
8	6	Southwest Research Institute	43	$20.2
9	12	Universities Space Research Assoc.	62	$20.2
10	11	University of Arizona	125	$18.4
11	14	Smithsonian Institution	120	$14.7
12	7	New Mexico State University — Las Cruces	22	$14.4
13	9	Massachusetts Institute of Technology	118	$11.8
14	13	Columbia University	79	$10.8
15	10	Wheeling Jesuit College	4	$9.8
16	15	University of Alaska — Fairbanks	30	$8.9
17	18	University of New Hampshire	69	$8.7
18	16	Stanford University	50	$8.2
19	21	University of Texas — Austin	58	$7.2
20	17	University of Washington	81	$6.8
21	26	University of California — Santa Barbara	51	$6.8
22	23	University of Wisconsin — Madison	68	$6.3
23	25	University of Hawaii	75	$6.2
24	50	Carnegie Mellon University	11	$6.1
25	22	University of California — Los Angeles	78	$6.0



Geographical Distribution Summary - FY99
Obligations by State - Place of Performance

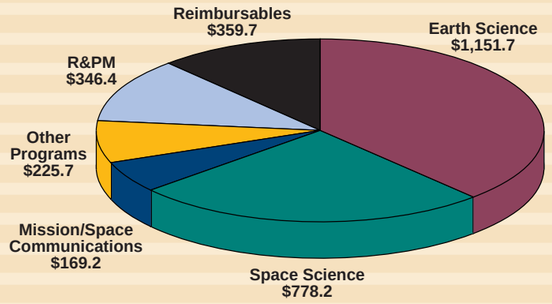
State	Total ($K)	State	Total ($K)
Alabama	$ 8,761	Montana	$ 8,599
Alaska	8,942	Nebraska	2,447
Arizona	23,910	Nevada	1,168
Arkansas	1,208	New Hampshire	13,819
California	358,629	New Jersey	88,366
Colorado	119,394	New Mexico	9,912
Connecticut	3,412	New York	37,238
Delaware	2,173	North Carolina	4,095
District of Columbia	53,288	North Dakota	2,616
Florida	12,007	Ohio	5,791
Georgia	3,396	Oklahoma	1,952
Hawaii	8,967	Oregon	6,807
Idaho	667	Pennsylvania	26,297
Illinois	9,906	Rhode Island	3,446
Indiana	49,027	South Carolina	3,032
Iowa	4,266	South Dakota	749
Kansas	1,413	Tennessee	3,268
Kentucky	2,512	Texas	49,227
Louisiana	5,249	Utah	3,105
Maine	1,522	Vermont	908
Maryland	994,702	Virginia	71,551
Massachusetts	45,479	Washington	13,750
Michigan	7,513	West Virginia	16,361
Minnesota	2,976	Wisconsin	6,701
Mississippi	680	Wyoming	492
Missouri	6,252	TOTAL	$2,117.948

Excludes Purchases <$25K

Resources

Goddard FY99 Budget ($M)

	FY99	FY98	FY97
Earth Science	$1,151.7	$1,117.9	$1,032.9
Space Science	778.2	869.2	836.8
Mission/Space Communications	169.2	265.0	396.2
Other Programs	225.7	150.4	171.7
R&PM	346.4	340.9	334.5
Subtotal Direct Appropriations	2,671.2	2,743.4	2,772.1
Reimbursables	359.7	336.0	265.2
Total	**$3,030.9**	**$3,079.4**	**$3,037.3**



Goddard Work Force (FTEs)
Civil Service & Contractor Support FTEs

	FY99
Earth Science	2,308.7
Space Science	2,085.8
Mission/Space Communications	2,163.4
Other Direct Programs	637.0
Indirects	1,784.9
Total	**8,979.8**

Financial Statements

Overview of Financial Statements

The Fiscal Year (FY) 1999 Financial Statements have been formulated to present the financial position and results of operations of NASA/Goddard Space Flight Center (GSFC), pursuant to the requirements of the Chief Financial Officers Act of 1990 and the Government Reform Act of 1994. These statements include the Statement of Financial Position and the Statement of Operations and Changes in Net Position. The statements have been prepared from the official accounting and budgetary records of GSFC (Basic Accounting System and Fiscal System) in accordance with the form and contents prescribed by the Office of Management and Budget (OMB) Bulletin 94-01.

The statements should be read with the realization that they reflect the component of a sovereign entity; that liabilities not covered by budgetary resources cannot be liquidated without the enactment of an appropriation; and that payment of all liabilities, other than contracts, can be abrogated by the sovereign entity.

There are nine direct appropriations included in GSFC's Financial Statements. The current appropriations are Human Space Flight (HSF), Science, Aeronautics and Technology (SAT), Mission Support (MS), Office of the Inspector General (OIG), and the Science, Space and Technology Education Trust Fund. Actual expenses for all appropriations including government and non-government reimbursable activities are reflected in the Financial Statements for FY 1999.

Our full cost initiative has evolved considerably during the past year. Significant effort has gone into developing the Center's approach in support of the Agency's full cost initiative, which will yield full cost disclosure on activities and improve matching of costs with performance. While we are still phasing into full cost, a full implementation will move us closer to emulating the private sector with respect to business planning, management and reporting.

Nancy Abell, Chief Financial Officer
Goddard Space Flight Center

Statement of Financial Position

As of September 30, 1999

(In Thousands)

	1999	1998
Assets		
Intragovernmental Assets:		
Fund Balance with Treasury (Note 2)	$ 1,429,862	$ 1,611,787
Accounts Receivable, Net (Note 3) – Federal Claims	45,892	71,989
Advances and Prepayments (Note 4)	2,749	3,435
Governmental Assets:		
Accounts Receivable, Net (Note 3) – Nonfederal Claims	2,211	7,994
Operating Materials & Supplies, Net (Note 5)	241,320	206,425
Property, Plant and Equipment, Net (Note 6)	2,216,432	2,762,800
Total Assets	**$3,938,466**	**$4,664,430**
Liabilities		
Liabilities Covered by Budgetary Resources:		
Intragovernmental Liabilities		
Accounts Payable	$ 50,411	$ 80,924
Other Liabilities (Note 7)	20,005	21,469
Governmental Liabilities		
Accounts Payable	628,934	807,224
Lease Liabilities (Note 8)	190	178
Other Liabilities (Note 7)	16,827	20,677
Total Liabilities Covered by Budgetary Resources	**716,367**	**930,472**
Liabilities Not Covered by Budgetary Resources:		
Intragovernmental Liabilities		
Other Liabilities (Note 7)	2,092	2,092
Governmental Liabilities		
Other Liabilities (Note 8)	121	500
Other Liabilities (Note 7)	31,609	29,876
Total Liabilities Not Covered by Budgetary Resources	**33,822**	**32,468**
Total Liabilities	**750,189**	**962,940**
Net Position (Note 9):		
Balances:		
Unexpended Appropriation	764,517	764,911
Invested Capital (Note 10)	2,457,441	2,968,547
Cumulative Results of Operations	20	—
Future Funding Requirements	(33,701)	(31,968)
Total Net Position	**3,188,277**	**3,701,490**
Total Liabilities and Net Position	**$3,938,466**	**$4,664,430**

The accompanying notes are an integral part of these statements.

Statement of Operations and Changes in Net Position

For the Year Ended September 30

(In Thousands)

	1999	1998
Revenues and Financing Resources:		
Appropriated Capital Used	$2,588,356	$2,935,655
Revenues from Sales of Goods & Services		
To the Public	16,048	18,506
Intragovernmental	342,375	356,355
Other Revenues and Financing Resources	4,490	13,420
Less: Receipts Transferred to Treasury	(4,490)	(13,420)
Total Revenues and Financing Resources:	**$2,946,779**	**$3,310,516**
Expenses:		
Program or Operating Expenses:		
Current Appropriations:		
Science Aeronautics and Technology	$2,128,938	$2,386,877
Human Space Flight	23,073	16,572
Mission Support	458,051	534,017
Office of Inspector General	8	8
Science, Space and Technology Education Trust Fund	(169)	228
Noncurrent Appropriations:		
Space Flight Control and Data Communications	(434)	(7,655)
Research and Development	(21,570)	4,647
Research and Program Management	(5)	35
Construction of Facilities	464	1,227
Bad Debts and Writeoffs	—	—
Reimbursable Expenses	358,423	374,861
Total Expenses:	**$2,946,779**	**$3,310,817**
Excess, (Shortage) of Revenues & Financing Sources Over Total Expenses	**$ —**	**$ (301)**
Changes in Net Position		
Nonoperating Changes:		
Unexpended Appropriations	$ (394)	$ (220,407)
Invested Capital	(511,106)	132,512
Cumulative Results of Operations	20	—
Future Funding Requirements	(1,733)	(3,923)
Total Nonoperating Changes	**$(513,213)**	**$ (91,818)**
Excess, (Shortage) of Revenues & Financing Sources Over Total Expenses	**$ —**	**$ (301)**
Net Position, Beginning Balance	**$3,701,490**	**$3,793,609**
Net Position, Ending Balance	**$3,188,277**	**$3,701,490**

Notes to the Financial Statements

Summary of Accounting Policies and Operations – Note 1

Basis of Presentation

In accordance with NASA's Chief Financial Officer (CFO) directive that installations begin the process of fulfilling the requirements legislated by the Chief Financial Officers Act of 1990, regarding the preparation of subject to audit financial statements (beginning FY 1996), these statements were formulated from the books and records of GSFC in conformity with form and content procedures specified in OMB Bulletin 94-01.

Reporting Entity

GSFC is one of nine NASA field centers established to assist NASA in its mission to provide for aeronautical and space activities. The financial management of NASA's operations is the responsibility of Center officials at all organizational levels. Ultimately, the Financial Management Division, Code 151, within the Office of the Center's Chief Financial Officer, is responsible for synthesizing, aggregating, and reporting accounting events to NASA Headquarters Code B and the Department of Treasury (for cash transactions), in accordance with Agencywide financial management regulations.

The GSFC overall accounting system consists of numerous feeder systems. When combined, they provide the basic information necessary to meet internal and external financial reporting requirements in terms of funds control and accountability. Albeit, it is recognized that the current systems do not meet OMB Circular A-127 requirements for a single integrated financial system. NASA is moving to implementing a fully integrated financial system. NASA contracted KPMG Peat Marwick to provide an off-the-shelf accounting package to accomplish this objective. Currently, Goddard is scheduled for deployment in FY 2001.

The following nine direct appropriations require individual treatment and are distinctly classified in GSFC combined accounting and control systems:

(1) **Human Space Flight (HSF)** – supports human space flight research and development activities for space flight, spacecraft control, and communications actions. This includes research, development, operations, services, maintenance, and construction of facilities, which encompass the repair, rehabilitation, and modification of real and personal property.

(2) **Space, Aeronautics and Technology (SAT)** – provides for the conduct and support of science, aeronautics, and technology programs. Research, development, operations, services, maintenance, and construction of facilities (repair, rehabilitation, and modification of real and personal property) also serve as by-products of this appropriation.

(3) **Mission Support (MS)** – funds safety, reliability and quality assurance activities in support of Agency programs and space communication services for NASA programs. The appropriation also provides budgetary resources for salaries, fringe benefits and related expenses, while supporting research and construction of facilities.

(4) The **Space Flight Control and Data Communication (SFCDC)** appropriation for program years 1994 and prior provides funding for space flight, expendable launch vehicles, spacecraft control, and communication activities, including operations, production services, related institutional activities, minor construction, maintenance, repair, rehabilitation and modifications.

(5) The **Research & Development (R&D)** appropriation for program years 1994 and prior provides funding for research and development contracts, as well as materials, supplies, and contractual services applied directly to the in-house performance of specific projects, programs, or tasks. R&D also provides for the institutional activities related to research and development.

(6) The **Research & Program Management (R&PM)** appropriation for program years 1994 and prior provides funding for civil servant salaries, fringe benefits, training, travel, and related expenses to manage and conduct NASA programs within GSFC.

(7) The **Construction of Facilities (C of F)** appropriation for program years 1994 and prior provides funding for construction, repair, rehabilitation and modification of facilities, minor construction of new facilities and additions to existing structures, and facility planning and design.

(8) **Office of the Inspector General (OIG)** – funds necessary for OIG salary, travel and related expenses required to conduct audits and investigations of Center activities.

(9) **Science, Space and Technology Education Trust Fund** – expenses of all property and services procured for the trust fund.

In addition to the direct appropriations, we receive funds from various federal and nonfederal customers to perform aeronautical and space activities on a reimbursable basis.

Basis of Accounting

GSFC accounts are maintained on an accrual basis (i.e., expenses are recorded when incurred and revenue when earned). Expenses are classified in the accounts by appropriation in accordance with the Agencywide coding structure, which sets forth a uniform classification of financial activity that is used for planning, budgeting, accounting, and reporting. The expenses are further categorized in the General Ledger as operating or capitalized expenditures.

Advances

GSFC distributes the majority of its funding used for the University Contracts and Grants Program by the method of Letter of Credit through the Health and Human Services (HHS) Payment Management System (PMS). The HHS serves as an agent for the U.S. Treasury in processing the drawdown of funds (disbursements) from a pre-established balance set up by GSFC based on contract/grant awards. The established balance for each University constitutes advance payments. A smaller number of university contract/grant recipients receive advance payments on a quarterly basis via check payments through the U.S. Treasury system. In accordance with OMB Circular A-110, quarterly financial reporting of transactions is provided by recipients on Federal Cash Transactions Reports (SF 272's). Detailed monitoring, funds control (against outstanding obligations), and accountability records are maintained. In addition, audits by the Defense Contract Audit Agency and NASA's OIG support this monitoring.

Property, Plant, and Equipment (PP&E)

GSFC-owned Property, Plant, and Equipment (PP&E) may be held by the Center or its contractors. Under the provisions of the Federal Acquisition Regulation (FAR), contractors are responsible for control over and accountability for such property in their possession. The GSFC General Ledger is capable of separately classifying Government-held PP&E from Contractor-held PP&E.

Government regulation does not make a provision for depreciating PP&E under appropriated funding authority. However, in accordance with the User Charge Act and OMB Circular A-25, NASA is permitted to assess depreciation charges for the use of facilities and equipment, under the "full cost" concept, to nongovernment reimbursable customers. In addition, automated data processing software is treated as operating cost rather than capitalized in accordance with GAO Title II guidelines.

Equipment with a unit cost of $100,000 or more and a useful life of two years or more and will not be consumed in an experiment is capitalized. Capitalized cost includes unit cost, transportation, installation, and handling and storage cost. Real property, such as land, buildings, and other structures and facilities, is capitalized when the asset value is $100,000 or more.

Land values are recorded at original acquisition cost and do not reflect current market value or include cost of improvements. Buildings are also valued at acquisition cost, including the cost of capital improvements and fixed equipment required for functional use of the facility.

Government-owned/Contractor-held property includes GSFC real property, such as land, buildings, and structures, materials, plant equipment, space hardware, special tooling, and special test equipment. Contractors are directed to report annually (on NASA Form 1018) plant equipment costing $100,000 or more and having a useful life of two years or more and will not be consumed in an experiment. In addition, this reporting includes capturing the other property categories mentioned above, regardless of the value (although most exceed $100,000), and is included in the Statement of Financial Position. This reporting is certified by the contractor's representative and reviewed by a government property administrator. Space hardware work-in-process represents the largest amount of assets owned by GSFC.

Revenues and Other Financing Sources

GSFC receives the majority of its funding through multiyear appropriations. These include three-year appropriations for construction activities, two-year appropriations for operational and space flight activities, and a single-year appropriation for civil service payroll and travel. In addition to appropriated funds, the Center performs services for federal and nonfederal customers upon receipt of customers funding authority.

NOTE 2 – FUND BALANCES WITH TREASURY *(In Thousands):*

	Obligated Available	Unobligated Available	Unobligated Restricted	Total
Appropriated Funds	$1,279,222	$122,120	$4,804	$1,406,146
Deposit Funds for Reimbursable Advances	23,716	—	—	23,716
Total Fund Balances with Treasury	**$1,302,938**	**$122,120**	**$4,804**	**$1,429,862**

GSFC cash receipts and disbursements are processed by the U.S. Treasury. The funds with the U.S. Treasury include appropriated funds, trust funds, and deposited funds for advances received for reimbursable services.

NOTE 3 – ACCOUNTS RECEIVABLE NET *(In Thousands):*

	Entity Accounts Receivable	Allowances for Losses on A/R & Interest	Net Amount Due
Intragovernmental	$45,892	$ —	$45,892
Governmental	2,241	(30)	2,211
Total Accounts Receivable	**$48,133**	**$ (30)**	**$48,103**

Accounts Receivable consist of amounts owed to GSFC by other Federal Agencies and amounts owed by the public. NASA establishes an allowance amount for reporting purposes based on an analysis of outstanding receivable balances. Most receivables are due from other Federal Agencies for reimbursement of services. Nonfederal customers provide advance payments which are placed on deposit with the U.S. Treasury until services are performed.

NOTE 4 – ADVANCES AND PREPAYMENTS *(In Thousands):*

	1999	1998	Change
Intragovernmental	$2,749	$3,435	($686)

See Note 1 for discussion on Advances and Prepayments.

NOTE 5 – OPERATING MATERIALS AND SUPPLIES *(In Thousands):*

	1999	1998	Change
Contractor-held Materials	$234,917	$201,127	$33,790
Stores Stock	6,349	5,253	1,096
Standby Stock	54	45	9
Total Operating Materials and Supplies	**$241,320**	**$206,425**	**$34,895**

NOTE 6 – PROPERTY, PLANT, AND EQUIPMENT *(In Thousands):*

Government-owned/Government-held	1999	1998	Change
Land	$ 5,473	$ 5,483	$ (10)
Structures, Facilities & Leasehold Improvements	494,008	513,930	(19,922)
Equipment	284,768	365,825	(81,057)
Assets Under Capital Lease	877	12,911	(12,034)
Work-in-Process	43,944	54,232	(10,288)
Total	**$829,070**	**$952,381**	**($123,311)**
Government-owned/Contractor-held			
Structures, Facilities & Leasehold Improvements	$ 7,461	$ 14,833	$ (7,372)
Equipment	45,489	24,891	20,598
Special Tooling	5,555	6,667	(1,112)
Special Test Equipment	63,120	79,682	(16,562)
Space Hardware	106,639	108,053	(1,414)
Work-In-Process	1,159,098	1,576,293	(417,195)
Total	**$1,387,362**	**1,810,419**	**($423,057)**
Grand Total	**$2,216,432**	**$2,762,800**	**($546,368)**

See Note 1 for discussion on Property, Plant, and Equipment.

NOTE 7 – OTHER LIABILITIES *(In Thousands):*

Liabilities Covered by Budgetary Resources:	Current	Non-Current	Total
Intragovernmental Liabilities:			
Liabilities for Deposit and Suspense Funds	$19,846	$ —	$19,846
Liabilities for Statistical Reimbursable Cost	159	—	159
Total	**$20,005**	**—**	**$20,005**
Governmental Liabilities:			
Liabilities for Deposit and Suspense Funds	$ 5,909	—	$ 5,909
Liabilities for Statistical Reimbursable Cost	5	—	5
Accrued Funded Payroll	10,913	—	10,913
Total	**$16,827**	**—**	**$16,827**
Total Liabilities Covered by Budgetary Resources	**$36,832**	**—**	**$36,832**

Liabilities Not Covered by Budgetary Resources:	Current	Non-Current	Total
Intragovernmental Liabilities			
Accounts Payable for Closed Appropriations	$ —	$2,092	$ 2,092
Liabilities for Receipts Accounts	—	—	—
Total	**$ —**	**$2,092**	**$ 2,092**
Governmental Liabilities:			
Accounts Payable for Closed Appropriations	$ —	$7,644	$ 7,644
Liabilities for Receipt Accounts	—	3	3
Unfunded Annual Leave	23,962	—	23,962
Total	**$23,962**	**$7,647**	**$31,609**
Total Liabilities Not Covered by Budgetary Resources	**$23,962**	**$9,739**	**$33,701**
Grand Total	**$60,794**	**$9,739**	**$70,533**

NOTE 8 – LEASE LIABILITIES *(In Thousands):*

Assets under Capital Lease:		
Equipment		$877
Accumulated Amortization		566

NASA capital leases consist of assorted ADP and copier equipment with non-cancelable terms longer than one year, a fair market value of $100,000 or more, a useful life of 2 years or more, and agreement terms equivalent to an installment purchase.

Future Lease Payments:	Fiscal Year	
	2000	$190
	2001	150
	Future Lease Payments	$340
	Less: Imputed Interest	(29)
	Capital Lease Liability	$311
Liabilities Covered by Budgetary Resources		$190
Liabilities Not Covered by Budgetary Resources		121
Total		**$311**

NOTE 9 – NET POSITION *(In Thousands):*

	Appropriated Funds
Unexpended Appropriations	
Undelivered	$637,593
Unobligated:	
Available	122,120
Unavailable	4,804
Invested Capital (Note 10)	2,457,441
Cumulative Results of Operations	20
Future Funding Requirements	(33,701)
Total Net Position	**$3,188,277**

NOTE 10 – INVESTED CAPITAL *(In Thousands):*

Property, Plant and Equipment	$2,216,432
Operating Materials and Supplies	241,320
Less: Liability for Capitalized Leases	(311)
Invested Capital	**$2,457,441**

Reaching Our Community

Administrator Goldin and Director Diaz share the honors of presenting "Thank You's" to Senator Mikulski during the Center's Anniversary Symposium.

Partners

During the past year, Goddard enjoyed partnering with the Maryland Space Business Roundtable, Prince Georges Conference and Visitors Bureau, High Technology Council of Maryland and the Prince Georges Economic Development Corporation, to share presentations and information that promote the values of a hi-tech environment in Maryland.

Goddard Public Affairs Consortium

Reaching the community by networking onsite contractor interests proved a major success for 1999. The Consortium participated in Anniversary events, sharing products with their employees and local neighborhoods; supported an education competition for middle schools; and actively kept their employees informed on Goddard's progress.

Visitor Center Impact

The Goddard Visitor Center offered its visitors during 1999 a variety of educational and community programs linked to Earth science, space science and advanced technology. These programs included tours, on- and off-site presentations, traveling exhibits, children's programs, open houses and special events. Nearly 3 million people were impacted by our programs this year alone. These programs are designed to enhance the technological and scientific literacy regarding the Goddard Space Flight Center, its accomplishments and its impact on the community at large. Audiences impacted included families, school groups, and organizations.

Local high school joins the festivities to honor Goddard in this Center parade.

Goddard Contractors Association

The Goddard Contractors Association (GCA) worked in partnership with Goddard management to promote the mutual interests of the Goddard Community. There were 14 additional members inducted this year, to bring the total membership to 35 companies. A series of monthly meetings with Goddard Senior Management focused on discussion topics for GSFC/GCA partnership action, including the GCA role for focusing contractor participation and activity reporting for GSFC's Safety-Day initiative. The GCA supported the Public Affairs Consortium and proactively worked with the new Wallops Contractors Association to strengthen ties and alignment of goals.

The most significant achievement for the GCA was the 15th Annual Goddard Contractors Association Quality Symposium. This event stressed the theme of continuous improvement and procurement innovations in project management. This symposium was the forum for presenting the 1999 Goddard Contractor Excellence Awards and the Quality and Process Improvement and Customer Service Excellence Awards.

"People who experience Goddard, whether by the media, education programs or tours, tell us how captivated they are by the unexpected treasures they find here."

Janet K. Ruff, Chief
Office of Public Affairs

Goddard Alliance

The Alliance was formed in 1996 as a nonprofit, civic organization to illustrate Goddard Space Flight Center as a positive economic and technology contributor to the Greenbelt community. Members come from state and local government, local businesses, educational institutions, and the Goddard contractor community. The Alliance strives to achieve a communitywide support infrastructure, provides a focal point for local industry, and encourages contractor-based Centers of Excellence. First and foremost, the Alliance networks with constituents and partner organizations with mutual interests in increasing exposure of the Center's achievements within the community.

Mayor Judith Davis of Greenbelt City presents Center Director Diaz with City Proclamation in honor of Goddard's 40th Anniversary.

Reaching Educators

During 1999, the development of programs and services to increase scientific literacy at the elementary school, middle school, high school, and higher education levels, continued with individual as well as organizational commitment and enthusiasm. Systemic support to schools, districts, and state education agencies in linking Goddard's unique mission in support of formal education and state standards became a powerful engine of Goddard's educational programs. Accomplishments included an increase in the Center's service to teachers, students, and curriculum efforts.

Goddard is proud to be working with the Maryland Business Roundtable and the Maryland State Department of Education School Library Division to team science and mathematics teachers with school librarians to impact the statewide movement to develop an Earth science curriculum and state assessment system. Within Maryland, Goddard continues its commitment to its 21-county

A 40-foot birthday cake on the Goddard mall to celebrate 40 years!

school system partnership for the development of Earth and space science training and curriculum materials.

The Connecticut statewide systemic partnership through the Connecticut/NASA Education Collaborative generated 24 workshops for educators throughout the state, reaching 280 teachers who will carry the message into 1520 classrooms. Connecticut is beginning to develop a model to determine the impact of NASA's educational programs and resources on the improvement of instruction in science, mathematics, and technology.

Likewise, the Maine State Department of Education drew upon Goddard's resources to train 40 Maine teachers participating in developing state-level Earth and space science standards.

In addition to its partnership strategy, the Center continued curriculum support by coordinating teacher development in 70 Earth and space science investigations for the middle and high school levels. NASA's Office of Space Science furthered Goddard's efforts in national education forums. For example, the NASA Sun-Earth Connection Education Forum is one of four national forums responsible for the development

Goddard employees were key participants in the Minority University Space Interdisciplinary Network (MUSPIN) annual conference held during the past year. At the sessions scientists and engineers spoke to teachers about Goddard programs.

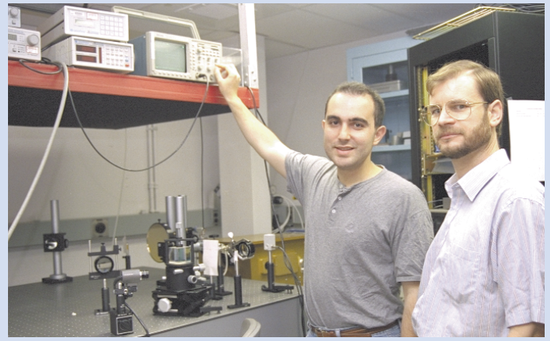
of space science education programs and products. A major feature of this forum was the webcasting of the last solar eclipse of the 20th century, attracting over 225,000 individuals to the GSFC solar eclipse website.

Goddard hosted an Education Showcase for 150 local teachers participating in a series of 25 curriculum support workshops conducted by scientists and engineers and related to Earth and space sciences and engineering missions. A particular strength of the workshops were the links to state and national standards in Earth and space sciences, mathematics, geography, and technology.

During the past year, efforts to serve underrepresented populations increased through partnerships with Morgan State University, the ASPIRA organization of New Jersey for the advancement of Hispanic

Mentored students work with engineers on projects.

Teachers perform hands-on investigations using guidance from Goddard researchers.



Teacher interns gain lab experience.

youth, and the Stevens Institute of Technology, and the Jersey City and Hoboken school districts distance mentoring program. In addition, Goddard hosted a Tribal Colleges Program that brought together representatives from tribal colleges across the country to examine how the Center can provide support to strengthen these institutions' efforts to recruit, prepare and sustain students underrepresented in mathematics and science-related fields. The Equal Opportunity Office expanded its relationships by developing a support program for underrepresented high school populations through Delaware State College that will assist in preparing underprivileged students in mathematics, science and technology to meet the national standards, and encourage them to pursue careers in science and technology.

In 1999, the Center hosted a GSFC urban initiative with the District of Columbia Public Schools through the SUNBEAMS program involving nine separate classes of sixth grade students, each coming to the Center for a full week of intensive instruction, and continued with the development of the integrated astronomy curriculum with D.C.'s Anne Beers Elementary School in cooperation with Glenn Research Center and Cleveland Public Schools.

Professionals from Goddard also developed and delivered workshops to groups preparing to apply remote sensing in their work environments. Presentations were conducted for the National Park Service-Inventory and Mapping Managers, Regional Global Information Systems Coordinators and American Meteorological Society Weather Broadcasters.

Education efforts were prominent at the Goddard Institute for Space Science (GISS) in New York City as well as at Wallops Flight Facility in Virginia. The two facilities created partnerships with state and local institutions to give educators and students access to educational resources available at NASA. These sites provide an avenue to reach underrepresented areas with the unique mission of NASA.

GISS, through its Institute on Climate and Planets, fostered research education and minority advancement in pre-college and undergraduate science. The Summer Institutes and the School Network program, a collaboration between GISS, the City University of New York, Columbia University and the New York City Urban Systemic Initiative, involved students, faculty and scientists in Earth climate studies via research. Course materials emphasized how research works.

At Wallops Flight Facility, opportunities abounded for hands-on science for students in kindergarten through college. Students proposed and built experiments for flight in the Space Experiment Module (SEM) on the space shuttle. Participants took an active role to de-integrate the SEM canisters following return from flight. At the high school level students flew experiments on a sounding rocket via the Suborbital Student Experiment Module. This program provides the students the opportunity to participate in the launch of the rocket. At the college level, the Student Launch Program provides students the opportunity to participate in flight experiments from conceptualization to data analysis.

In 1999, for the first time, Wallops employees reached schools in the northeastern U.S. through the use of video-conferencing. This technology allows NASA personnel to interact with students discussing a variety of topics including rocketry and student flight programs.

TOP LEFT: Sharing Ideas with Sisters in Engineering and Research Science (SISTER). SISTER is an Equal Opportunity Program Office five-day program for 7th grade girls going into the 8th grade. The purpose is to increase the awareness of and provide opportunities for middle school girls to explore nontraditional career fields with Goddard women engineers, mathematicians, scientists, and researchers.

TOP CENTER: Participants in the first-ever University Day gathered at the Center in September 1999. Scientific and technology researchers from more than 60 colleges and universities from across America joined Goddard scientists and engineers to exchange ideas and discuss opportunities for future collaborations. During the two-day conference the Center invited world-class speakers from government and academia to discuss future research objectives for possible partnering opportunities, and explore joint proposal efforts.

TOP RIGHT: Students and teachers from New York review technical papers during a poster session at the annual Minority University Space Interdisciplinary Network (MUSPIN) Goddard-sponsored conference held in New Mexico. Educators from around the country participate in this minority education activity.

Comments from You

These are examples of feedback we receive from our customers:

NASA Administrator Daniel Goldin

"NASA Goddard's commitment to excellence in the Earth sciences over the past year — from the launch of Landsat-7 to the measuring of hurricanes, oceans and ozone — continues to make NASA the world leader in Earth system science. As we move into the new millennium, the Goddard team will not only play a pivotal role in our understanding of planet Earth, it is also vital to us as we explore the cosmos. From the inner workings of the Sun, to the incredible topography of Mars, to the discoveries the Next Generation Space Telescope will unveil, the NASA Goddard team holds the keys to unlocking the mysteries of our universe."

Dr. Ghassem Asrar, NASA Associate Administrator for Earth Science

"I consider GSFC an outstanding and unique establishment for the conduct of Earth and space sciences. I believe GSFC is one of the few places around the world where there is a unique blend of first-class scientists and engineers with access to cutting-edge technologies to conduct and further Earth and space sciences. The NASA Office of Earth Science is privileged and proud to have the GSFC team on its side."

Dr. Ed Weiler, NASA Associate Administrator for Space Science

"Goddard's role in space science this past year has been pivotal, not just in announcing numerous cosmic discoveries and building several missions which we successfully launched, but also by laying the foundations for a robust program in future years. A wealth of exciting discoveries ranging from a deeper understanding of our Sun and planets to galaxies at the very edges of the universe came from Goddard scientists and missions this year. And Goddard's management of the Next Generation Space Telescope program, a worthy successor for Hubble, is something all Americans can be proud of."

James Baker, NOAA Administrator

"NOAA and NASA have a history of interagency cooperation which started with the first flight of TIROS I in 1960, and which has been reaffirmed through our agreement of 1998. The accurate weather forecasts and better understanding of our environment that have come from this partnership are one of the great scientific achievements of the 20th Century. The Goddard Space Flight Center has been an integral part of this relationship, sharing specialized technical, scientific and operational expertise. We're proud to reiterate our commitment to the partnership."

Senator Paul S. Sarbanes, Maryland

"Goddard is important to Maryland and the Nation. Its people and programs represent a critical mass for advancing our high-tech economy into the 21st Century."

Senator Barbara Mikulski, Maryland

"I fought for the priorities of our country and for Maryland. I fought to invest in the future of science and technology. I'm on the side of NASA employees and the thousands of men and women who work at the Goddard Space Flight Center and other NASA Centers around the country."

Congressman Steny Hoyer, Fifth District, Maryland

"There is no limit to the scientific progress our Nation can make in the new millennium and I know that the Goddard Space Flight Center will be at the forefront, leading the way for our journeys to new and uncharted territory."

Judith F. Davis, Mayor of Greenbelt, Maryland

"The City of Greenbelt has been exceedingly proud of the many accomplishments made by the scientists and support staff at the Goddard Space Flight Center throughout its 40 years. The City has supported Goddard's mission and considers the Center a major stakeholder in the community and a greatly valued neighbor."

Robert M. Allen, Director of Operations, Greenbelt Marriott

"Goddard Space Flight Center is a great neighbor. Many of our guests enjoy the extended presence of space and Earth visuals at the hotel as well as visiting the Center for business or pleasure."

Dyan Brasington, President of the High Technology Council of Maryland

"NASA Goddard is a marvelous resource for the technology community in Maryland. Goddard's many inspiring programs with our educational institutions, together with their efforts in sharing technology innovation, provides an excellent backdrop for our growing economy and our future."

Mr. Matt Neitzey, Executive Director of the Prince Georges County Conference and Visitors Bureau

"Goddard Space Flight Center is a high-tech magnet and a major driver for our County's economy from both a business attraction and tourism standpoint. Best of all for our visitors, Goddard is a fun place! Our County's tourism and hospitality industry is both proud and grateful to claim Goddard Space Flight Center as one of our top attractions."

James Strandquist, Science Coordinator for Prince Georges County Schools

"Goddard Space Flight Center has provided opportunities for students and teachers to support and enhance Prince Georges County Schools' reform efforts. Teachers, through internships and workshops, use the cutting-edge science and technology to upgrade teacher skills in technology, and Earth and space sciences."

Nagi T. Wakim, Ph.D., Special Assistant to the President and Professor of Computer Science, Bowie State University

"I believe that Goddard offers the best of two worlds: academia and industry. Over the last 13 years, I have been affiliated with Goddard in many different ways and have worked with scientists and managers. Bowie State University's rich relationship with Goddard spans over three decades. Our collaboration with NASA in general, and GSFC in particular, helped us develop a viable infrastructure in science and technology and to engage our students in the latest and greatest scientific and technological projects in support of key NASA strategic enterprises, especially Earth science. We are fortunate and grateful to be affiliated with such a world-class scientific environment."

Conclusion

The past year offered numerous challenges and opportunities to explore space and the Earth. Through the efforts and hard work of a talented and professional staff, and using the most innovative technologies available, we achieved excellent results and served the needs of our customers. Because of these efforts, we know more today about the universe and the interactions of the Earth's systems. We know more today about the violence of hurricanes, the power of climate change and the enormous global consequences of an El Niño and La Niña. We also know more today about the Sun's tremendous influence on our planet, the origins of the solar winds, and the nature of mysterious black holes. We even detected new classes of objects in the universe that before now were beyond our comprehension. As remarkable as these and many other achievements appear, some would say, "it is all in a day's work" at NASA's Goddard Space Flight Center.

The coming year promises equal if not greater challenges to our unquenchable thirst for knowledge about the solar system and the Earth. We will improve our comprehensive modeling capabilities, increase the breadth of computing and data storage systems, and provide continued leadership for the Sun-Earth Connection and Structure and Evolution of the Universe. We will advance the state-of-the-art for the Next-Next generation of Astro-Physics Observatories.

We will accomplish remarkable outcomes in the year ahead because of the innovation and hard work of our people. With the strong and continued support of our communities, the Goddard Space Flight Center will make a glorious entrance into the New Millennium.

In Memoriam

Harry Goett
1910-2000
First Center Director

NP-2000-1-001-GSFC