

National Aeronautics and Space Administration



GoddardView

Volume 5 Issue 9

Goddard's New Building Opens for Business

Pg 3

Senator Barbara Mikulski Unveils First Images
from Rejuvenated *Hubble*

Pg 6

Swift Makes Best-Ever Ultraviolet Portrait of
Andromeda Galaxy

Pg 8

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This Month in Goddard History

By Rob Garner

“This Month in Goddard History” is a series celebrating the Center’s history through stories and photos from the archives of the Goddard News. ■



Caption: The same year the Goddard Visitor Center was constructed, a “moon tree” was planted in front of the new structure. Moon trees were grown from seeds flown aboard the Apollo 14 spacecraft. Dozens of moon trees continue to thrive in locations across the United States (from the September 1977 issue of “Goddard News”).



Caption: The Goddard moon tree today.

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Volume 5 Issue 9

Table of Contents

Goddard Updates

- This Month in Goddard History – 2
- Goddard’s New Building Opens for Business – 3
- NASA Launches Virtual Trip to Jupiter – 4
- Goddard’s *Lunar Reconnaissance Orbiter* Begins Detailed Mapping of Moon’s South Pole – 5
- Senator Mikulski Unveils First Images from Rejuvenated *Hubble* – 6
- Swift* Makes Best-Ever Ultraviolet Portrait of Andromeda Galaxy – 8
- Tracking and Data Relay Satellite Flight 1* Recovery Team at Goddard Selected for AIAA Award – 9
- With an Eye on Locusts and Vegetation, Scientists Make a Good Tool Better – 10
- Extreme Ultraviolet Variability Experiment: Measuring the Sun’s Hidden Variability – 11

Goddard Family

Employee Spotlight

John Pak – 12

Cover caption: Goddard Center Director Rob Strain (left) and U.S. Representative Steny Hoyer cut the ribbon in front of the Exploration Sciences Building.

Photo credit: Pat Izzo

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Goddard's New Building Opens for Business

By Rob Gutro

Goddard held a ribbon cutting ceremony on September 28 for NASA employees to mark the opening of its newest building.

The ceremony to christen the three-story Exploration Sciences Building, known on campus as Building 34, was open only to NASA employees and featured remarks from Goddard Center Director Rob Strain and U.S. House Majority Leader Steny Hoyer.

"Fifty years ago, leaders representing a newly formed space agency broke ground on the first building for a new space research center here in Greenbelt, Maryland, that would become the Goddard Space Flight Center," Strain said. "Today, we are officially opening a new Exploration and Sciences Building that will ensure NASA's continued leadership at the forefront of scientific discovery for decades to come. Within these walls, scientists and technologists will ponder instruments and spacecraft to gather information that could answer some of the fundamental science questions of our age."

"The completion of the Exploration Sciences Building (ESB) is a major accomplishment for the overall development of the Goddard Facilities Master Plan," said David Larsen, ESB Project Manager at Goddard. "This new phase of development allows for Code 600 employees (Earth and space science) to consolidate relocated operations in both Building 34 and the recently renovated Building 21.

"The ESB offers a new dimension in laboratory design, providing flexibility and capability not previously experienced," Larsen said. "The building also leads the Agency in green building design, becoming the Agency's largest green building and achieving a USGBC (United States Green Building Council) Gold rating."

One of the factors that contribute to the ESB's rating is its "green" roof. The roof is actually painted a brilliant white to reflect the Sun's heat. Having a "green," or environmentally friendly, roof is a USGBC Leadership in Energy and Environmental Design (LEED)-compliant feature and was one of the many features that helped the building achieve its USGBC Gold certification.

The building was also designed to foster collaboration among scientists. Collaboration areas are located in the building's center on each floor near a centralized staircase. The design concept was based on an idea to encourage scientists to cross paths and engage one another towards the next new exciting discovery. There is also a Conference Hallway located on the first floor and an oversized Symposium Room capable of seating 200 persons.

A large skylight at the centralized staircase allows natural light to spill throughout the top two floors of the collaboration area. To assist with easy navigation throughout the building, each floor is uniquely color coded.

The building's laboratories have a number of special features. Lab floors are all made from epoxy flooring. Silicone or organic compounds are not used because of off-gassing. Off-gassing means that volatile chemicals in non-metal materials evaporate into the air at normal atmospheric pressure.



Photo credit: Pat Izzo

Caption: Astrophysicist F. Scott Porter shows Steny Hoyer one of the many state-of-the-art laboratories in the new Exploration Sciences Building.

Building materials can release chemical gases and odors into the air as they evaporate, and that process can last for years after the products are installed. Silicone couldn't be used in the laboratories either, because it gets into optics of satellites. Lab floors are grounded to prevent electrostatic discharge so static electricity doesn't disrupt electrical equipment. Lab spaces can also be manipulated to create one, two, or three separate areas, and even sectioned. Each area will still have its own lab racks, lighting, and air ventilation. There are also several laboratories with black walls, floors, furniture, and fixtures to prevent light reflectivity problems when scientists are developing and testing optics. While many of these rooms are using lasers, only some of the current laser use requires the black walls.

Some of the other features that contribute to ESB's green building status include: large reflective paving areas to reduce heat island effect; site lighting designed to reduce light pollution; plumbing fixtures to reduce water usage; no Chlorofluorocarbons ozone depleting HCFCs/Halons in the building; reduced energy usage; a proactive storm water management system; recyclables areas; chemical use areas and copy rooms are separated, vented, and at negative pressure to prevent odor distribution; and a manifold exhaust system that allows separation of hazardous and non-hazardous lab exhaust and recirculation of non-hazardous lab exhaust thereby reducing energy costs.

The USGBC is a 501(c)(3) non-profit community of leaders working to make green buildings available to everyone within a generation. The LEED Green Building Rating System is a voluntary, consensus-based national standard for developing high-performance, sustainable buildings.

The new building was designed by EwingCole Architects and was built by the Manhattan Construction Company of Fairfax, Va. ■

NASA Launches Virtual Trip to Jupiter

By Bill Steigerwald

On September 15, the Goddard Visitor Center transported Goddard employees to Jupiter from the comfort of the Science On a Sphere Theater. Viewers felt like they are in orbit around the largest planet in our solar system as images based on data from NASA missions were projected onto a 6-foot sphere in the center of the theater.

"The movie has incredible visual appeal," said astrophysicist Amy Simon-Miller of Goddard, who was a scientific consultant for the production. "We think it will engage people and get them interested in learning more about Jupiter and planetary exploration."

Called "Largest," the film is based on data from NASA's robotic missions to the outer solar system, including *Voyager*, *Galileo*, and *Cassini*, as well as *Hubble Space Telescope* observations. Watching the movie sends viewers on a journey stretching more than five times the Earth-Sun distance. Jupiter is a gas giant—more than 11 times wider than Earth—with a small core forever shrouded beneath a cloak of toxic, roiling clouds and oceans of liquid metallic hydrogen tens of thousands of miles deep.



Caption: Goddard employees fill the Science On a Sphere theater at the Visitor Center to watch the premier of "Largest."

Viewers were treated to up-close-and-personal encounters of the Great Red Spot, a storm larger than Earth that's been raging for hundreds of years. They'll also experience dramatic fireballs with up to six million megatons of explosive power from the impacts of doomed comet Shoemaker-Levy 9, which left planet-sized "bruises" of soot hanging for months in the Jovian atmosphere.

As virtual astronauts, visitors will also explore Jupiter's swirling mini-solar system of more than 60 moons, including tormented Io, which gushes fountains of molten sulfur over a hundred miles high, and fractured Europa, which may harbor oceans of liquid water, and possibly life, beneath its cracked, icy crust.

Science On a Sphere is an exciting new projection technology developed by the National Oceanic and Atmospheric Administration (NOAA). "LARGEST" is the latest in a series of films for the Sphere created by the team at Goddard using new techniques and technology of their own, designed specifically for making spherical movies. In fact, "LARGEST" pushed the team to develop several new presentation techniques demonstrated throughout the film. Goddard released the world's first major spherical film in 2006 called "FOOTPRINTS."



Caption: The Goddard science and production team that created "LARGEST." From left: Sallie Smith, David Williams, Amy Simon-Miller, Victoria Weeks, and Michael Starobin.

"Jupiter is not only a perfect subject for the Sphere, but also simply a great subject for a movie," said Senior Producer Michael Starobin. "It presents itself as a regal, mighty character, and we tried hard to invest its cinematic depiction with as much commanding grandeur as possible. This is a movie that takes viewers somewhere way out of the ordinary. It brings abstract ideas to vibrant life and makes the fifth planet real in fresh, unexpected ways. This was a thrilling project to develop." Starobin wrote, produced, and directed the film.

"LARGEST" was funded by NASA's Educational and Public Outreach in Earth and Space Science program at NASA Headquarters, Washington. The science and educational outreach team includes Simon-Miller and David Williams of NASA Goddard, Maurice Henderson of Adnet Systems, Inc., Rockville, Md., Pamela Clark of the Catholic University of America, Washington, Louis Mayo of Honeywell Technology Solutions, Inc., and Sallie Smith of Lux Consulting Group, Silver Spring, Md. Over a dozen people from Goddard's Scientific Visualization Studio and Conceptual Image Lab pioneered the techniques used to make the film (complete credits are available at the Web site below).

To find the nearest Science on a Sphere theater, and for more images and information about Jupiter, refer to: <http://www.nasa.gov/largest>. ■

Goddard's *Lunar Reconnaissance Orbiter* Begins Detailed Mapping of Moon's South Pole

By Nancy Neal Jones and Bill Steigerwald

NASA showcased new images from the *Lunar Reconnaissance Orbiter's* seven instruments and provided updates about the topography of the Moon's south pole during a news conference on September 17. NASA also provided an update about the spacecraft's status and mission plans. The briefing took place at Goddard Space Flight Center.

NASA reported at the news conference that the *Lunar Reconnaissance Orbiter* (LRO) has successfully completed its testing and calibration phase and entered its mapping orbit of the Moon. The spacecraft already has made significant progress toward creating the most detailed atlas of the Moon's south pole to date.

"The LRO mission already has begun to give us new data that will lead to a vastly improved atlas of the lunar south pole and advance our capability for human exploration and scientific benefit," said Richard Vondrak, LRO Project Scientist at Goddard.

LRO is scheduled for a one-year exploration mission in a polar orbit of about 31 miles above the lunar surface, the closest any spacecraft has orbited the Moon. During the next year, LRO will produce a complete map of the lunar surface in unprecedented detail, search for resources and safe landing sites for human explorers, and measure lunar temperatures and radiation levels.

"The LRO instruments, spacecraft, and ground systems continue to operate essentially flawlessly," said Craig Tooley, LRO project manager at Goddard. "The team completed the planned commissioning and calibration activities on time and also got a significant head start collecting data even before we moved to the mission's mapping orbit."

The south pole of the Moon is of great interest to explorers because potential resources such as water ice or hydrogen may exist there. Permanently shadowed polar craters that are bitterly cold at their bottoms may hold deposits of water ice or hydrogen from comet impacts or the solar wind. The deposits may have accumulated in these "cold-trap" regions over billions of years. If enough of these resources exist to make mining practical, future long-term human missions to the Moon could potentially save the considerable expense of hauling water from Earth.

First results from LRO's Lunar Exploration Neutron Detector (LEND), indicate that permanently shadowed and nearby regions may harbor water and hydrogen. Additional observations will be needed to confirm this. LEND relies on a decrease in neutron radiation from the lunar surface to indicate the presence of water or hydrogen.

"If these deposits are present, an analysis of them will help us understand the interaction of the Moon with the rest of the solar system," Vondrak said. Data from LRO's Lunar Orbiter Laser Altimeter (LOLA), however, indicates that exploring these areas will be challenging because the terrain is very

rough. The roughness is probably a result of the lack of atmosphere and absence of erosion from wind or water, according to David Smith, LOLA Principal Investigator at Goddard.

LRO's other instruments are providing data to help map the Moon's terrain and resources. According to the first measurements from the Diviner instrument, large areas in the permanently shadowed craters are about -400° F, more than cold enough to store water ice or hydrogen for billions of years.



Photo credit: Bill Hrybyk

Caption: Goddard employees gather in the Building 3 auditorium to watch the LRO news conference.

The Lunar Reconnaissance Orbiter Camera is providing high-resolution images of permanently shadowed regions while lighting conditions change as the Moon's south pole enters lunar summer.

LRO's Lyman Alpha Mapping Project (LAMP) is also preparing to search for surface ice in the polar regions. The instrument provides images of permanently shadowed regions illuminated only by starlight and the glow of interplanetary hydrogen emission. LAMP has provided information to confirm the instrument is working well on both the lunar night and day sides.

The Mini RF Technology Demonstration on LRO has confirmed communications capability and produced detailed radar images of potential targets for LRO's companion mission, the Lunar Crater Observation and Sensing Satellite, which will impact the Moon's south pole on Oct. 9.

Meanwhile, LRO's Cosmic Ray Telescope for the Effects of Radiation instrument is exploring the lunar radiation environment and its potential effects on humans during record high, "worst-case" cosmic ray intensities accompanying the extreme solar minimum conditions of this solar cycle.

Goddard built and manages LRO, a NASA mission with international participation from the Institute for Space Research in Moscow. Russia provides the neutron detector aboard the spacecraft.

For more information about LRO and to view the new images, visit: <http://www.nasa.gov/lro>. ■

Senator Mikulski Unveils First Images from Rejuvenated *Hubble*

By J.D. Harrington and Susan Hendrix

Astronomers declared NASA's *Hubble Space Telescope* a fully rejuvenated observatory with the release of observations from four of its six operating science instruments. Senator Barbara Mikulski unveiled the images at NASA Headquarters.

Topping the list of new views are colorful, multi-wavelength pictures of far-flung galaxies, a densely packed star cluster, an eerie "pillar of creation," and a "butterfly" nebula. *Hubble's* suite of new instruments allows it to study the universe across a wide swath of the light spectrum, from ultraviolet all the way to near-infrared. In addition, scientists released spectroscopic observations that slice across billions of light-years to probe the cosmic-web structure of the universe and map the distribution of elements that are fundamental to life as we know it.

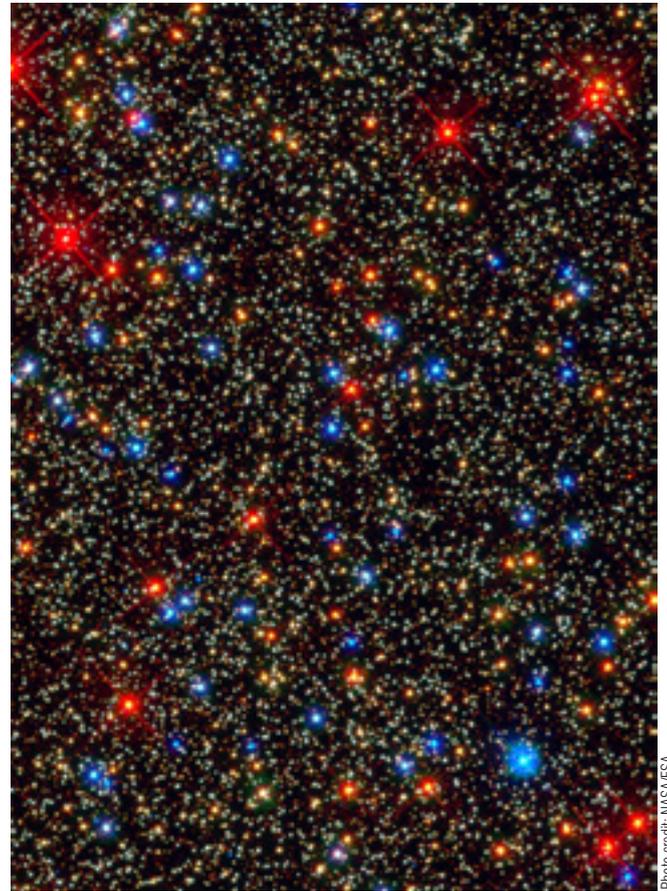
"This marks a new beginning for *Hubble*," said Ed Weiler, Associate Administrator for NASA's Science Mission Directorate at NASA Headquarters. "The telescope was given an extreme makeover and now is significantly more powerful than ever, well-equipped to last into the next decade."

"I fought for the *Hubble* repair mission because Hubble is the people's telescope," said Mikulski, Chairwoman of the Commerce, Justice, and Science Appropriations Subcommittee that funds NASA. "I also fought for *Hubble* because it constantly rewrites the science textbooks. It has more discoveries than any other science mission. *Hubble* is our greatest example of our astronauts working together with scientists to show American leadership and ingenuity. I want to salute Team *Hubble*—everyone who worked on *Hubble* from the Goddard Space Flight Center and Space Telescope Science Institute scientists in Maryland, to the ground crew at the Kennedy Space Center, to the Johnson Space Center where the astronauts train, and to the astronauts who were heroes in space."



Caption: U.S. Senator Barbara A. Mikulski delivers remarks during a press conference where NASA unveiled new images from the Hubble Space Telescope.

The new instruments are more sensitive to light and will improve *Hubble's* observing efficiency significantly. It is able to complete observations in a



Caption: The Hubble Space Telescope snapped this panoramic view of a colorful assortment of 100,000 stars residing in a small region inside the massive globular cluster Omega Centauri, which boasts nearly 10 million stars. Globular clusters, ancient swarms of stars united by gravity, are the homesteaders of our Milky Way galaxy. The stars in Omega Centauri are between 10 billion and 12 billion years old.

fraction of the time that was needed with prior generations of *Hubble* instruments. The space observatory is now significantly more powerful than ever.

"We couldn't be more thrilled with the quality of the images from the new Wide Field Camera 3 and repaired Advanced Camera for Surveys, and the spectra from the Cosmic Origins Spectrograph and the Space Telescope Imaging Spectrograph," said Keith Noll, leader of a team at the Space Telescope Science Institute in Baltimore, Md., which planned the early release observations. "The targets we've selected to showcase the telescope reveal the great range of capabilities in our newly upgraded *Hubble*."

These results are compelling evidence of the success of the STS-125 servicing mission in May, which has brought the space observatory to the apex of its scientific performance. Two new instruments, the Wide Field Camera 3 and Cosmic Origins Spectrograph, were installed, and two others, the Advanced Camera for Surveys and Space Telescope Imaging Spectrograph, were repaired at the circuit board level. Mission scientists also announced that the Near Infrared Camera and Multi-Object Spectrometer were brought back into operation during the three months of calibration and testing.

Continued on Page 7

Senator Mikulski Unveils First Images from Rejuvenated *Hubble*

Continued from Page 6

"On this mission, we wanted to replenish the 'tool kit' of *Hubble* instruments on which scientists around the world rely to carry out their cutting-edge research," said David Leckrone, Senior Project Scientist for *Hubble* at Goddard. "Prior to this servicing mission, we had only three unique instrument channels still working, and today we have 13. I'm very proud to be able to say, 'mission accomplished.'"



Photo credit: NASA/ESA

Caption: This image of barred spiral galaxy NGC 6217 is the first image of a celestial object taken with the newly repaired Advanced Camera for Surveys (ACS) aboard the Hubble Space Telescope.

For the past three months, scientists and engineers at the Space Telescope Science Institute and Goddard have been focusing, testing, and calibrating the instruments. *Hubble* is one of the most complex space telescopes ever launched, and the *Hubble* servicing mission astronauts performed major surgery on the 19-year-old observatory's multiple systems. This orbital verification phase was interrupted briefly July 19 to observe Jupiter in the aftermath of a collision with a suspected comet.

Hubble now enters a phase of full science observations. The demand for observing time will be intense. Observations will range from studying the population of Kuiper Belt objects at the fringe of our solar system to



Photo credit: NASA/ESA

Caption: This portrait of Stephan's Quintet, also known as Hickson Compact Group 92, was taken by the new Wide Field Camera 3 (WFC3) aboard NASA's Hubble Space Telescope. The image, taken in visible and infrared light, showcases WFC3's broad wavelength range.

surveying the birth of planets around other stars and probing the composition and structure of extrasolar planet atmospheres. There are ambitious plans to take the deepest-ever near-infrared portrait of the universe to reveal never-before-seen infant galaxies that existed when the universe was less than 500 million years old. Other planned observations will attempt to shed light on the behavior of dark energy, a repulsive force that is pushing the universe apart at an ever-faster rate.

The *Hubble Space Telescope* is a project of international cooperation between NASA and the European Space Agency. Goddard manages the telescope. The Space Telescope Science Institute conducts *Hubble* science operations. The institute is operated for NASA by the Association of Universities for Research in Astronomy, Inc. in Washington, D.C. and is an International Year of Astronomy 2009 program partner.

For images and more information about the *Hubble Space Telescope*, visit: <http://www.nasa.gov/hubble>. ■

Swift Makes Best-Ever Ultraviolet Portrait of Andromeda Galaxy

By Francis Reddy

In a break from its usual task of searching for distant cosmic explosions, NASA's *Swift* satellite has acquired the highest-resolution view of a neighboring spiral galaxy ever attained in the ultraviolet. The galaxy, known as M31 in the constellation Andromeda, is the largest and closest spiral galaxy to our own.

"*Swift* reveals about 20,000 ultraviolet sources in M31, especially hot, young stars and dense star clusters," said Stefan Immler, a research scientist on the *Swift* team at NASA's Goddard Space Flight Center in Greenbelt, Md. "Of particular importance is that we have covered the galaxy in three ultraviolet filters. That will let us study M31's star-formation processes in much greater detail than previously possible."

M31, also known as the Andromeda Galaxy, is more than 220,000 light-years across and lies 2.5 million light-years away. On a clear, dark night, the galaxy is faintly visible as a misty patch to the naked eye.

Between May 25 and July 26, 2008, *Swift*'s Ultraviolet/Optical Telescope (UVOT) acquired 330 images of M31 at wavelengths of 192.8, 224.6, and 260 nanometers. The images represent a total exposure time of 24 hours. The task of assembling the resulting 85 gigabytes of images fell to Erin Grand, an undergraduate student at the University of Maryland at College Park who worked with Immler as an intern this summer. "After ten weeks of processing that immense amount of data, I'm extremely proud of this new view of M31," she said.



Caption: This mosaic of M31 merges 330 individual images taken by the Ultraviolet/Optical Telescope aboard NASA's Swift spacecraft. It is the highest-resolution image of the galaxy ever recorded in the ultraviolet.

Several features are immediately apparent in the new mosaic. The first is the striking difference between the galaxy's central bulge and its spiral arms. "The bulge is smoother and redder because it's full of older and cooler stars," Immler explained. "Very few new stars form here because most of the materials needed to make them have been depleted."

Dense clusters of hot, young, blue stars sparkle beyond the central bulge. As in our own galaxy, M31's disk and spiral arms contain most of the gas and dust needed to produce new generations of stars. Star clusters are especially plentiful in an enormous ring about 150,000 light-years across.

What triggers the unusually intense star formation in Andromeda's "ring of fire"? Previous studies have shown that tides raised by the many small satellite galaxies in orbit around M31 help boost the interactions within gas clouds that result in new stars.

In 1885, an exploding star in M31's central bulge became bright enough to see with the naked eye. This was the first supernova ever recorded in any galaxy beyond our own Milky Way. "We expect an average of about one supernova per century in galaxies like M31," Immler said.

"*Swift* is surveying nearby galaxies like M31 so astronomers can better understand star formation conditions and relate them to conditions in the distant galaxies where we see gamma-ray bursts occurring," said Neil Gehrels, the mission's Principal Investigator at Goddard. Since *Swift*'s November 2005 launch, the satellite has detected more than 400 gamma-ray bursts—massive, far-off explosions likely associated with the births of black holes.

Swift is managed by Goddard. It was built and is being operated in collaboration with the Pennsylvania State University, the Los Alamos National Laboratory in New Mexico, and General Dynamics of Gilbert, Ariz.. International

collaborators include the University of Leicester and Mullard Space Sciences Laboratory in the United Kingdom, Brera Observatory and the Italian Space Agency in Italy, and additional partners in Germany and Japan.

For more images and a video tour of M31, visit:

http://www.nasa.gov/mission_pages/swift/bursts/uv_andromeda.html. ■

Tracking and Data Relay Satellite Flight I Recovery Team at Goddard Selected for AIAA Award

By Susan Hendrix

The American Institute of Aeronautics and Astronautics (AIAA) Space Operations and Support Award for 2009 has been given to the NASA/Boeing *Tracking and Data Relay Satellite Flight I* (TDRS I) Recovery Team. The award is given biennially for outstanding efforts in overcoming space operations problems and assuring mission success, and recognizes those teams or individuals whose exceptional contributions were critical to an anomaly recovery, crew rescue, or space failure.

TDRS I was one of three satellites developed by Boeing Space and Intelligence Systems of El Segundo, Calif., for NASA Goddard Space Flight Center. The trio of satellites was launched between 2000 and 2002 and replenished the original constellation, which has provided communication services to the Space Shuttle and other orbiting spacecraft since 1983.

The TDRS-I award citation reads: "In recognition of exceptional efforts, innovation, and outstanding accomplishment in the recovery of the TDRS-I satellite from its geosynchronous transfer orbit to its placement into the intended operational orbit resulting in its successful operation supporting spacecraft communications." The award is comprised of an engraved bronze medal, a certificate of citation, and a rosette pin.

Jeff Gramling, TDRS Project Manager at Goddard, accepted the award on behalf of the TDRS I Recovery Team on September 16, 2009 at an awards luncheon held in conjunction with the AIAA Space Conference and Exhibit at the Pasadena Convention Center in Pasadena, Calif., with the team also being recognized in the AIAA monthly *Aerospace America* magazine.



Photo credit: Boeing

Caption: NASA and Boeing engineers, members of the TDRS-I recovery team, gather outside the former Boeing Mission Control Center in El Segundo, Calif., for a group photo, which was taken in 2002.

The team overcame a potentially catastrophic propulsion system problem that was discovered early in the geosynchronous transfer orbit phase. A large, multidisciplinary team of Boeing and NASA engineers, working nonstop for nine months, devised an ingenious workaround to access the seemingly unusable propellant in the second fuel tank. Once accessed, the propellant was used to boost the satellite to its intended geosynchronous orbit. TDRS I has been operational since acceptance following completion of in-orbit testing and is one of nine spacecraft that currently comprises the NASA Space Network.

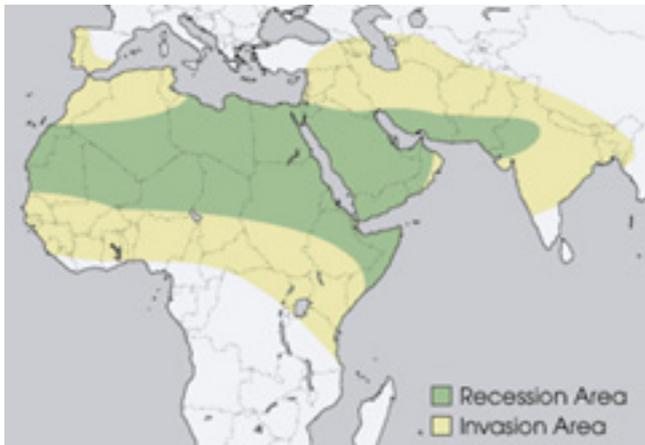
"The TDRS-I recovery was a phenomenal engineering and operational achievement spanning half a year, with each of the many maneuvers designed, developed into procedures, and rehearsed based on the results of the preceding maneuver, leaving the team uncertain of ultimate success until the very end," said Gramling. "I am extremely proud to be a part of this incredibly cohesive team." ■

With an Eye on Locusts and Vegetation, Scientists Make a Good Tool Better

By Adam Voiland

Locusts, the grasshopper-like insects of Biblical lore, are normally docile creatures that prefer solitary lives in the desert, away from other members of their species. But sometimes, when the rains come and patches of green begin to dot dry landscapes, their populations skyrocket and something extraordinary can happen. Hormonal changes, triggered by crowding, can cause the insects to change color, become more active, and congregate in huge swarms capable of decimating crops.

In the 1980s, scientists at NASA's Goddard Space Flight Center and the United Nations' Food and Agriculture Organization (FAO) teamed up to develop a monitoring system that used satellite observations and other environmental data to monitor vegetation in the deserts of Africa, the Middle East, and Asia for signs that swarms may be imminent. The Desert Locust Information Service (DLIS) used the satellite-derived Normalized Difference Vegetation Index (NDVI)—based on the ratio of red and infrared radiation reflecting off the leaves of plants—to detect where deserts were greening the most.

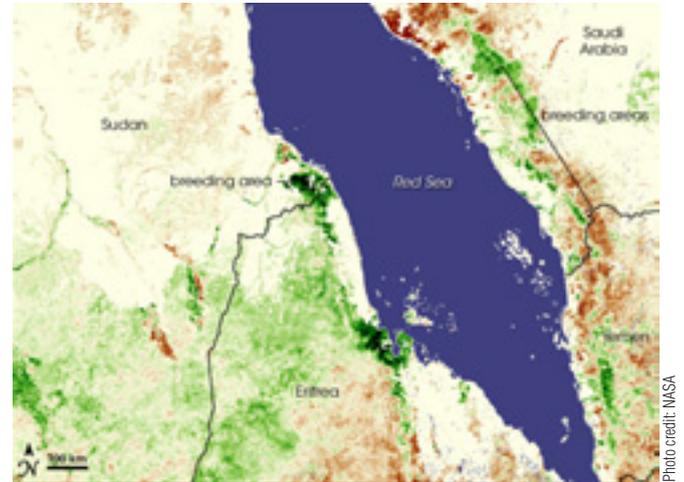


Caption: During quiet periods, known as recessions, desert locusts live within the semi-arid and arid areas of Northern Africa. However, as shown in yellow, desert locusts can spread over a much larger area during swarms.

Compared to previous attempts to study vegetation from space, NDVI was a vast improvement. Scientists could determine whether plant growth was significantly more or less productive than usual over a given time period—just what they needed to predict whether locusts were likely to swarm. The advance gave officials precious time to target worrisome locust populations with pesticides before they could swarm and take their toll on crops.

Though state-of-the-art at the time, the system had a few shortcomings. For instance, bare soil in deserts can register an NDVI value similar to that of sparse vegetation. As a result, DLIS has occasionally issued false alarms, interpreting vegetation growth where there was none and missing the development of some real vegetation.

“If DLIS warns locust control teams of a risk and then it doesn't materialize, or if it misses places where vegetation and swarms may be developing, then officials could be less apt to mobilize the next time,” said Pietro Ceccato, an associate research scientist at Columbia University in New York, who has also worked with the FAO on its locust monitoring system.



Caption: Swarms are not visible from space, but vegetation that they depend upon is readily detectable. In green, this NDVI-based map shows areas with especially lush vegetation, which serve as fertile locust breeding grounds.

That system has evolved over the years, particularly since the arrival of the Moderate Resolution Imaging Spectroradiometer (MODIS) instruments on NASA's *Terra* and *Aqua* satellites, which offer a considerably better view than previous instruments. Since 2002, locust monitors at DLIS have supplemented NDVI with information from an additional channel—the shortwave infrared—to create composite images that better account for the differences between vegetation and bare soil.

While NDVI remains the most important tool available to monitor locusts from space, remote sensing specialists are hardly resting on their NDVI laurels. For instance, the Goddard group that helped create NDVI and FAO's locust monitoring system continues to refine its ability to screen out extraneous data and increase image resolution.

The impulse to refine NDVI isn't limited to locust studies. Small particles in the atmosphere (aerosols) and water vapor can make interpreting NDVI measurements difficult in some situations, explained Susan Ustin, a remote sensing expert at the University of California-Davis. Clouds, especially thin cirrus clouds, also can contaminate short-term measurements. And the color of soil can cause complications because vegetation over dark soils produces higher NDVI values than the same amount of vegetation over light soils.

As technology has advanced, scientists have attempted to overcome such problems by developing dozens of experimental indices, many of which are based upon NDVI. “It seems like a new index comes out every month,” said Ustin. In fact, there are so many new indices being developed for such a variety of situations that it's sometimes difficult for researchers to agree on which are worth pursuing.

“Most of the new indices will never make it out of the lab,” said Steve Running, a vegetation scientist at the University of Montana. “But I think that we'll eventually come up with one or two alternatives that we can use to complement NDVI.” ■

Extreme Ultraviolet Variability Experiment: Measuring the Sun's Hidden Variability

By Tony Phillips

Every 11 years, the Sun undergoes a furious upheaval. Dark sunspots burst forth from beneath the Sun's surface. Explosions as powerful as a billion atomic bombs spark intense flares of high-energy radiation. Clouds of gas big enough to swallow planets break away and billow into space. It's a flamboyant display of stellar power.

So why can't we see any of it?

Almost none of the drama of solar maximum is visible to the human eye. Look at the Sun in the noontime sky and it looks the same as ever.

"The problem is, human eyes are tuned to the wrong wavelength," explains Tom Woods, a solar physicist at The University of Colorado in Boulder. "If you want to get a good look at solar activity, you need to look in the EUV."

EUV is short for extreme ultraviolet, a high-energy form of ultraviolet radiation with wavelengths between 1 and 120 nanometers. EUV photons are much more energetic and dangerous than the ordinary UV rays that cause sunburns. Fortunately for humans, Earth's atmosphere blocks solar EUV; otherwise a day at the beach could be fatal.

When the Sun is active, solar EUV emissions can rise and fall by factors of hundreds to thousands in just a matter of minutes. These surges heat Earth's upper atmosphere, puffing it up and increasing the air friction, or "drag," on satellites. EUV photons also break apart atoms and molecules, creating a layer of ions in the upper atmosphere that can severely disturb radio signals.

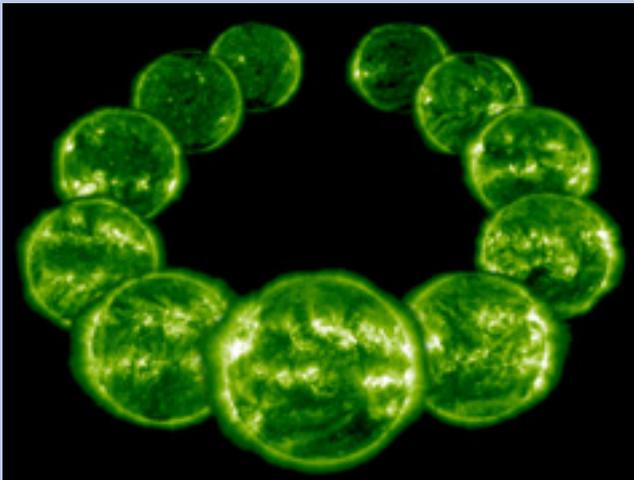


Photo credit: NASA

Caption: The extreme ultraviolet (EUV) Sun imaged by the Solar and Heliospheric Observatory (SOHO) over one complete solar cycle. The Sun changes more at EUV wavelengths than it does in any other part of the electromagnetic spectrum.

To monitor these energetic photons, NASA is going to launch a sensor named "EVE," short for EUV Variability Experiment, onboard the *Solar Dynamics Observatory* (SDO) this winter.

"EVE gives us the highest time resolution and the highest spectral resolution that we've ever had for measuring the Sun, and we'll have it 24/7," says Woods, the lead scientist for EVE. "This is a huge improvement over past missions."

Although EVE is designed to study solar activity, its first order of business is to study solar inactivity. SDO is going to launch during the deepest solar minimum in almost 100 years. Sunspots, flares, and coronal mass ejections are at low ebb. That's okay with Woods. He considers solar minimum just as interesting as solar maximum.

"Solar minimum is a quiet time when we can establish a baseline for evaluating long-term trends," Woods explains. "All stars are variable at some level, and the Sun is no exception. We want to compare the Sun's brightness now to its brightness during previous minima and ask: is the Sun getting brighter or dimmer?"

The answer seems to be dimmer. Measurements by a variety of spacecraft indicate a 12-year lessening of the Sun's irradiance by about 0.02% at visible wavelengths and 6% at EUV wavelengths. These results, which compare the solar minimum of 2008-09 to the previous minimum of 1996, are still very preliminary. EVE will improve confidence in the trend by pinning down the EUV spectrum with unprecedented accuracy.

The Sun's variability and its potential for future changes are not fully understood—hence the need for EVE. "The EUV portion of the Sun's spectrum is what changes most during a solar cycle," says Woods, "and that is the part of the spectrum we will be observing."

As Woods gazes out his office window at the Colorado Sun, it looks the same as usual. EVE, he knows, will have a different story to tell. SDO is designed to help us understand the Sun's influence on Earth and near-Earth space by studying the solar atmosphere on small scales of space and time and in many wavelengths simultaneously. SDO is managed by Goddard. For more information on SDO, visit: <http://sdo.gsfc.nasa.gov>. ■

Employee Spotlight: John Pak

By Christina Coleman



Photo credit: Pat Izzo

Caption: John Pak.

It is a welcome sight for many that the Goddard community ranges in ethnicity, background, and gender. Among Goddard's diverse community, however, is a population that may have John Pak, a Program Specialist in the Office of Human Capital Management, to thank. Pak and a team of Program Specialists are eagerly working to implement the "2% by 2010" program. The program's goal is to increase the percentage of individuals with disabilities to two percent of every Government Agency's workforce by 2010.

With Goddard already the leading Agency in percentage of people with disabilities, it is not this feat that makes Pak special. Nor is it his own visual impairment, which he has lived with all his life. Instead, it is his dedication to advocate for persons with disabilities that is really making a change, not only at Goddard, but at Government Agencies Nationwide.

"I really try and sell the individual," Pak said. "They are disabled, but they do have the ability to work. They might need some assistance but they can do the job," he said of the 44 individuals already at Goddard.

Pak facilitates meetings with potential managers to prepare them for having a disabled person on their team. He then picks from a pool of recruits with help from the NASA Staffing and Recruitment System (STARS); the Maryland, Virginia, and Washington, D.C. Departments of Rehabilitation;

and Schedule A, a special hiring authority that allows people with disabilities to apply non-competitively. Pak then briefs managers about the challenges and the benefits they may come across.

"I put their abilities and skills first, their disabilities last," Pak said. One of the goals is to make sure the employer is comfortable with the disability. "It helps that I'm blind. I will take any questions they have. Honestly, I'd rather get those questions now than it become a problem later," he added.

Pak insists that the questions, which range from the quality of work an individual can do to how they get dressed in the morning, aren't daunting or offensive. "I've heard it all before," Pak said. "I think it's politically incorrect to not have the discussion."

When asked how he copes with his own disability, Pak answered with the same easy flowing spirit and determination. "Being blind is another part of who I am. Of course there are going to be bad days. But I'm here to knock down social barriers."

Janine Dolinka, the Student Program Coordinator in the Office of Human Capital Management and Pak's officemate, insists that she sometimes forgets that Pak has a disability. "It's no different. He's involved in my work and he totally adds to our office," Dolinka said.

Dolinka met Pak at a career fair. She knew then that he would be a great fit at Goddard. "He has a degree in communications and we always need to communicate in a way that costumers need to understand," Dolinka said. "He was new and young and able to communicate to Generation Y and others." The team and Pak "have already made leaping strides with meeting the goals of 2% by 2010."

Pak credits his office for his success with the progression of the program, as well as his overall accomplishments everyday. "I am successful because of them," he said. Although he uses devices such as Braille, electronic dictionaries, scanning software and Job Access With Speech (JAWS) to help him perform everyday tasks, it is evident that he doesn't need much assistance, if any at all, which mirrors the potential employees that he represents.

When Pak isn't advocating for disabled persons, he is pursuing his master's degree in public administration at Indiana State University. He is also a member of the NASA Goddard Amateur Radio Operator Club. He just purchased a home two years ago, which, he admits, "takes up most of his time." ■