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MAVEN TAKES FLIGHT

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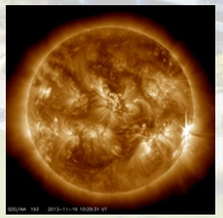
GoddardView

THE WEEKLY

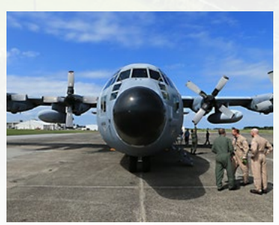
Behind the Badge
To ensure that all employees are familiar with the NASA Goddard Code of Conduct, Goddard's Office of Communications is rolling out the Behind the Badge campaign. Click the image to learn more.

Sun Sends Out X-Class Solar Flare
An X1-class flare erupts from the right side of the sun, captured by Solar Dynamics Observatory on Nov. 19, 2013. The flare erupted from a region that produced many flares in its two-week journey across the face of the sun. Click on the image to learn more.



Webb Super Eye Arrives at Goddard
The Webb Telescope NIRSpec instrument arrived at NASA Goddard and NASA videographers documented it. The video shows NIRSpec after its delivery as it was unloaded off a truck, moved into a clean room and situated by engineers for inspection. To learn more and see the video, click on the picture.

Airborne Campaign to Map Greenland Ice Sheet Summer Melt
With winter closing in, a new NASA airborne campaign got under way in Greenland. For the first time, the Laser Vegetation Imaging Sensor is flying aboard NASA's new C-130 aircraft to measure the island's ice following a summer's melt. For more information, click the photo.



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On the cover: The United Launch Alliance Atlas V rocket with NASA's Mars Atmosphere and Volatile Evolution spacecraft launches on Monday, Nov. 18, 2013, from Cape Canaveral, Florida. NASA's Mars-bound spacecraft, MAVEN, is the first spacecraft devoted to exploring and understanding the Martian upper atmosphere. Photo credit: NASA/Bill Ingalls

GoddardView

Goddard View is an official publication of NASA's Goddard Space Flight Center. Goddard View showcases people and achievements in the Goddard community that support Goddard's mission to explore, discover, and understand our dynamic universe. Goddard View is published weekly by the Office of Communications.

News items for publication in *Goddard View* must be received by noon Wednesday of each week. You may submit contributions to the editor via e-mail at john.m.putman@nasa.gov. Ideas for new stories are welcome but will be published as space allows. All submissions are subject to editing.

MAVEN LAUNCHES ON TEN-MONTH JOURNEY TO MARS

By: Dwayne Brown Nancy Neal Jones and George Diller

A NASA mission that will investigate how Mars lost its atmosphere and abundant liquid water launched into space at 1:28 p.m. EST Monday from Cape Canaveral Air Force Station in Florida.

The agency's Mars Atmosphere and Volatile Evolution spacecraft separated from an Atlas V Centaur rocket's second stage 53 minutes after launch. The solar arrays deployed approximately one hour after launch and currently power the spacecraft. MAVEN now is embarking on a 10-month interplanetary cruise before arriving at Mars next September.

"MAVEN joins our orbiters and rovers already at Mars to explore yet another facet of the Red Planet and prepare for human missions there by the 2030s," NASA Administrator Charles Bolden said. "This mission is part of an integrated and strategic exploration program that is uncovering the mysteries of the solar system and enabling us to reach farther destinations."

In the next four weeks, MAVEN will power on and check out each of its eight instruments. Upon arrival at Mars in September, the spacecraft will execute an orbit insertion maneuver, firing six thrusters that will allow it to be captured by Mars' orbit. In the following five weeks, MAVEN will establish itself in an orbit where it can conduct science operations, deploy science appendages, and commission all instruments before starting its one-Earth-year scientific primary mission.

"After 10 years of developing the mission concept and then the hardware, it's incredibly exciting to see MAVEN on its way," said Bruce Jakosky, principal investigator at the University of Colorado Boulder's Laboratory for Atmospheric and Space Physics in Boulder, Colo. "But the real excitement will come in 10 months, when we go into orbit around Mars and can start getting the science results we planned."

MAVEN is traveling to Mars to explore how the Red Planet may have lost its atmosphere over billions of years. By analyzing the planet's upper atmosphere and measuring current rates of atmospheric loss, MAVEN scientists hope to understand how Mars transitioned from a warm, wet planet to the dry desert world we see today.

"The team overcame every challenge it encountered and still kept MAVEN on schedule and on budget," said David Mitchell, MAVEN project manager at NASA's Goddard Space Flight Center in Greenbelt, Md. "The government, industry and university partnership was determined and focused to return to Mars sooner, not later."

MAVEN's principal investigator is based at CU/LASP. The university provided science instruments and leads science operations, as well as education and public outreach, for the mission. Goddard manages the project and provided two of the science instruments for the mission. Lockheed Martin built the spacecraft and is responsible for mission operations. The University of California at Berkeley's Space Sciences Laboratory provided science instruments for the mission. NASA's Jet Propulsion Laboratory in Pasadena, Calif., provides navigation support, Deep Space Network support, and Electra telecommunications relay hardware and operations. ■

Above: The United Launch Alliance Atlas V rocket lifts off from Space Launch Complex-41 at Cape Canaveral Air Force Station carrying MAVEN. Photo credit: NASA

"...the longest two-way laser communication ever demonstrated."

HISTORIC DEMONSTRATION PROVES LASER COMMUNICATION POSSIBLE

By: Dewayne Washington

In the early morning hours of Oct. 18, NASA's Lunar Laser Communication Demonstration made history, transmitting data from lunar orbit to Earth at a rate of 622 Megabits-per-second. That download rate is more than six times faster than previous state-of-the-art radio systems flown to the moon.

"It was amazing how quickly we were able to acquire the first signals, especially from such a distance," said Don Cornwell, LLCD manager. "I attribute this success to the great work accomplished over the years by the Massachusetts Institute of Technology Lincoln Laboratory and their partnership with NASA."

LLCD is being flown aboard the Lunar Atmosphere and Dust Environment Explorer satellite known as LADEE, currently orbiting the moon. LADEE is a 100-day robotic mission designed, built, tested and operated by a team from NASA's Ames Research Center in Moffett Field, Calif. Its primary science mission is to investigate the tenuous and exotic atmosphere that exists around the moon.

LADEE, with LLCD onboard, reached lunar orbit 30 days after launch from NASA's Wallops Flight Facility on Wallops Island, Va., on Sept. 6. During the trip, the LADEE team provided an opportunity for LLCD to make post-flight calibrations of its pointing knowledge. "Being able to make those calibrations allowed us to lock onto our signal almost instantaneously when we turned on the laser at the moon," said Cornwell. "A critical part of laser communication is being able to point the narrow laser beam at a very small target over a great distance."

LLCD not only demonstrated a record-breaking download rate but also an error-free data upload rate of 20 Mbps. The laser beam was transmitted 239,000 miles from the primary ground station at NASA's White Sands Complex in Las Cruces N.M., to the LADEE spacecraft in lunar orbit. This breakthrough technology has a laser-based space terminal that is half the weight of a comparable radio-based terminal while using 25 percent less power.

These first tests of the month-long demonstration have included the successful LLCD transmission, by pulsed laser beam, of two simultaneous channels carrying high-definition video streams to and from the moon. Proving the capability to communicate with multiple locations, LLCD successfully transmitted its beam several times to NASA's Jet Propulsion Laboratory's Optical Communications Telescope Laboratory in California. Testing will soon include transmissions originating from the European Space Agency's Optical Ground Station in Tenerife, Spain.

The tests also confirmed LLCD's capability of providing continuous measurements of the distance from the Earth to the LADEE spacecraft with an unprecedented accuracy of less than half an inch. "We hope this demonstration validates the capabilities and builds confidence in laser communication technology for consideration on future missions," said Cornwell.

LLCD has also transmitted large data files from the LADEE spacecraft computer to Earth. "These first results have far exceeded our expectation," said Cornwell. "Just imagine the ability to transmit huge amounts of data that would take days in a matter of minutes. We believe laser-based communications is the next paradigm shift in future space communications."

Future testing will include how well the system operates in optically stressed conditions such as daytime (all operations have been at night), full moon verses new moon, and different pointing positions for the ground terminals. "These series of tests will allow us to sample different conditions to demonstrate the flexibility of the technology," said Cornwell.

The LLCD system was designed, built and is being operated by the MIT/LL team in Lexington, Mass. NASA's Goddard Space Flight Center manages LLCD. The LADEE spacecraft was built and is operated by NASA's Ames Research Center in Moffett Field, Calif. Additional ground terminals have been provided by NASA's Jet Propulsion Laboratory in Pasadena, Calif., and ESA in Darmstadt, Germany.

NASA's laser communications between LLCD and Earth ground stations is the longest two-way laser communication ever demonstrated. It is the first step and part of the agency's Technology Demonstration Missions Program, which is working to develop crosscutting technology capable of operating in the rigors of space.

The Laser Communications Relay Demonstration is the follow-on mission, scheduled for launch in 2017. Also managed at Goddard, LCRD will demonstrate laser relay communications capabilities for Earth-orbiting satellites continuously over a period of two to five years.

"LLCD is the first step on our roadmap toward building the next generation of space communication capability," said Badri Younes, NASA's deputy associate administrator for space communications and navigation, which sponsored LLCD. "We are encouraged by the results of the demonstration to this point, and we are confident we are on the right path to introduce this new capability into operational service soon." ■

Opposite: Artist's rendering of LADEE with LLCD onboard. Image credit: NASA

HIGH ENERGY PRAIRIE VIEW A&M INTERNS COLLABORATE WITH NASA GODDARD ON RADIATION EFFECTS RESEARCH

By: Cynthia O'Carroll

When Alvin Boutte presented his graduate work at the 2010 National Society of Black Engineers Aerospace Systems Conference in Los Angeles, Calif., he had no idea that he was about to connect with someone that would be instrumental in guiding his career. In attendance was Anthony Sanders from the Applied Engineering and Technology Directorate at NASA Goddard.

The radiation engineering work that Boutte did at Prairie View A&M University in Prairie View, Texas fit the skills Sanders needed for the Radiation Effects and Analysis Group of the Flight Data Systems and Radiation Effects Branch. The two met and a formal partnership developed with the Prairie View Center for Radiation Engineering and Science for Space Exploration.

REAG has sought ways to draw students into the narrow field of radiation engineering. Prairie View A&M University, a historically black university located between Austin and Houston, was created in 1876 and is a member of the Texas A&M University System. NASA funds CRESSE through the University Research Center program. The URC program was established to build research infrastructure at minority-serving schools relevant to NASA missions. Because Prairie View A&M also has a radiation effects program, the framework for a fruitful collaboration already existed.

"The mission of CRESSE is to encourage, facilitate and mentor students—especially minority and underrepresented student groups—in research and education in science, technology, engineering and mathematics. We also focus on the interactions of ionizing radiation on humans, devices and materials," said Sanders, assistant chief for operations of the AETD electrical engineering division. "Our unique collaboration provides a great training ground for their interns to gather real work experience in this highly technical field."

Boutte now leads several efforts within REAG, including serving as a discipline engineer in the Integrated Design Center's Mission Design and Instrument Design Labs, serving as the radiation engineering lead on the Search and Rescue/Global Positioning System instrument, as well as supporting several other major flight projects as a radiation engineer. Boutte is also the branch safety representative and has made several excellent contributions to branch laboratory operational procedures and practices.

"As a Prairie View alumnus, I really enjoy returning to recruit and to encourage the students in CRESSE to continue exploring the field," said Boutte. "I grew up in the Houston area, and just like many of them, I was in this same program a few short years ago. I am able to help them see the possibilities of a career in this unique field."

The work of REAG involves characterizing and quantifying the effects of the space radiation environment on electronics, photonics and materials. This usually includes both analysis and ground-based testing. The team gets involved early in the mission formulation stage, reviewing the mission parameters and developing an appropriate radiation-engineering program tailored for that project. The latter stages of project support include reviewing and approving electronic component lists, hardware designs and performing ground-based radiation testing. The ground-based testing uses radioactive sources and particle accelerators to produce a proxy for the natural space radiation environment. Radiation parts' testing is extremely important to ensure reliable operation of all electronic components in the harsh space environment.

Students in the CRESSE program can intern at Goddard and may also have the opportunity to see radiation testing in person, which is often conducted at the Texas A&M Cyclotron Facility in College Station, Texas, a short drive from the Prairie View A&M main campus. A cyclotron is used to simulate the space radiation environment within the practical limits of the accelerator hardware. The space radiation environment includes very high-energy particles, which are difficult if not impossible to replicate in ground-based equipment, so the comparison is not always one-to-one.

Prairie View intern Brandon Norman spent the last two summers working in the radiation effects lab and is graduating in 2014. "Dr. Wilkins and the team at Goddard helped me to transfer my knowledge of microelectronics to the radiation testing of similar components. It has been very challenging, but is rewarding to think that the microelectronics that I tested may become part of a spacecraft orbiting a planet."

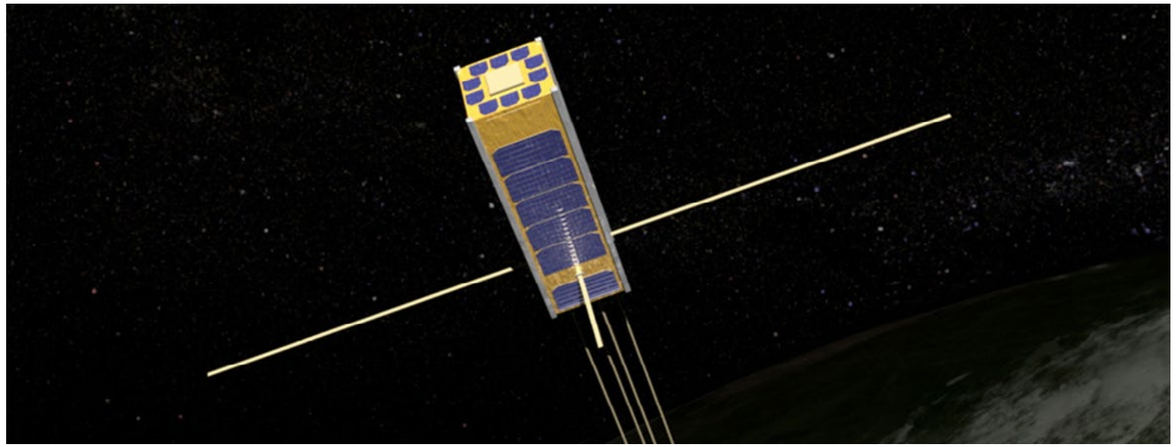
REAG considers many factors when assessing electronic components for mission managers: are there either in-flight or ground-based data on this part already, what level of radiation can the project live with and still conduct the science mission; should the project choose different parts to reduce the impact of radiation effects but not eliminate them, what non-destructive consequences can they live with? Radiation effects engineering is multi-disciplinary field requiring extensive knowledge of physics, electrical engineering, materials engineering and systems engineering.

The CRESSE center at Prairie View wants to structure their program to better meet the needs of the aerospace industry. This summer, the lab hosted the director of CRESSE along with an intern.

"Working directly with the radiation effects researchers here at Goddard will help us tailor the program at Prairie View and allow students to better understand what the real world challenges are in this field," stated Dr. Richard Wilkins, director of the CRESSE program, upon spending a month at NASA Goddard, immersed in the workings of the lab.

"Although we have plenty of radiation data on components used in the past, technology is always evolving and it is critical that we maintain a robust staff of civil servants and contractors to address radiation effects issues with new technologies such as memory devices, field programmable gate arrays, microprocessors, power distribution electronics and application-specific integrated circuits," said Jonathan Pellish, associate head of the Flight Data Systems and Radiation Effects Branch at Goddard. "This partnership with CRESSE allows us to develop skilled researchers that will help NASA solve critical issues so that we can be ready for future space flight missions." ■

Above: Brandon Norman (Prairie View A&M University) working on a prototype circuit to evaluate several operational amplifiers for their response to total ionizing dose radiation effects. Norman is currently enrolled at Prairie View A&M University. Photo credit: NASA



FIREFLY MISSION TO STUDY LIGHTNING

By: Karen C. Fox

Somewhere on Earth, there's always a lightning flash. The globe experiences lightning some 50 times a second, yet the details of what initiates this common occurrence and what effects it has on the atmosphere—lightning may be linked to incredibly powerful and energetic bursts called terrestrial gamma ray flashes—remains a mystery. In mid-November, a football-sized mission called Firefly, which is funded by the National Science Foundation, will launch into space to study lightning and these gamma ray flashes from above.

The Firefly instrument is what's known as a cubesat, a very small satellite that offers the chance for quality space science with a relatively inexpensive price tag.

"We can do great science with these small missions," said Doug Rowland, the principal investigator for Firefly at NASA Goddard. "Firefly will gather up to a year of observations on the mysterious workings of lightning. Lightning is so familiar we tend to take it for granted, but we really don't know the details of how it works—even though it is a critical part of the global electric circuit, and has obvious social and technological effects."

Lightning is ubiquitous and intimately connected to life on Earth, but we don't often think about what's happening higher up in the atmosphere. The radiation generated by lightning is so intense that it can generate antimatter and gamma rays within TGFs just a few miles of the ground. NASA's Compton Gamma Ray Observatory first discovered TGFs in the 1990s. Designed to look outward at cosmic sources of gamma rays, the mission also caught rare but tantalizing glimpses of gamma rays coming from Earth.

"Gamma rays are thought to be emitted by electrons traveling at or near the speed of light when they're slowed down by interactions with atoms in the upper atmosphere," said Therese Moretto Jorgensen, program director in NSF's Division of Atmospheric and Geospace Sciences, which funds Firefly. "TGFs are among our atmosphere's most interesting phenomena."

The electrons needed to create gamma rays have to be moving so fast and carrying so much energy, that scientists were at a loss to explain what process near Earth could kick them up to such high speeds. Indeed, prior to the discovery of TGFs, scientists thought electrons moving this fast could only be generated near much larger bodies such as stars, galaxies or black holes.

Lightning by itself is thought to be only a tenth as strong as would be needed to accelerate the electron beams to such incredible speeds, but scientists have hypothesized that perhaps some lightning is triggered by an electron avalanche, a runaway chain reaction that pushes electrons up to these incredible speeds. Understanding the mechanism for what accelerates the electron beams near Earth will help scientists understand how the same process happens throughout the rest of the universe.

"The idea that some of the lightning overhead may be triggered by the same processes that happen in supernovas and cosmic particle accelerators is mind-blowing," said Rowland. "I've never looked at thunderstorms the same way since learning about these ideas."

The NSF CubeSat program represents a low cost access to space approach to performing high-quality, highly targeted science on a smaller budget than is typical of more comprehensive satellite projects, which have price tags starting at $100 million. The CubeSat Firefly, by focusing its science goals, will carry out its mission in a much smaller package and at a considerably lower cost.

The Firefly mission also emphasizes student involvement as part of the ongoing effort to train the next generation of scientists and engineers. Students at Siena College, in Loudonville, N.Y., and the University of Maryland Eastern Shore, in Princess Anne, Md., were involved in all phases of the Firefly mission. ■

Above: An artist's rendition of the Firefly satellite. Firefly's mission is to study the relationship between lightning and huge bursts of gamma rays called terrestrial gamma ray flashes. Image credit: NASA/Goddard

A YEAR OF ACCOLADES, AND NOW ANOTHER

By: Lori Keesey

Goddard engineer Tom Flatley, who has spent the past several years enhancing the Goddard-developed SpaceCube flight processor and finding new applications for the more powerful technology, has received his share of accolades this year, and now he has another to add to his curriculum vitae.

The Office of the Chief Technologist has announced that it has chosen Flatley as its 2013 "IRAD Innovator of the Year," a prize it awards annually to those who exemplify the best in innovation and contribute substantially to NASA's mission and goals.

"His accomplishments, as evidenced by his vigorous pursuit of new SpaceCube products and applications, made him a stand-out within Goddard's technology community this year. He richly deserves not only our recognition but also that of the American Astronautical Society, which bestowed its 2012 William Randolph Lovelace II Award on him earlier this year," said Goddard Chief Technologist Peter Hughes.

SpaceCube Offers Alternative

Ten to 100 times faster than the current radiation-hardened flight processors SpaceCube offers science missions a much-needed alternative for science-data processing (successfully proven in certain low-Earth orbits), particularly those requiring more robust computing power to handle significantly higher data rates from a smaller, more energy-efficient platform, Hughes said.

SpaceCube achieves its data-crunching prowess because Flatley and his team have married commercial radiation-tolerant Xilinx Virtex field programmable gate array technology to Goddard-developed algorithms that detect and correct radiation-induced upsets. Results from the MISSE7 SpaceCube experiment (six resets in three years, with a 99.9979% uptime) demonstrate that SpaceCube can operate reliably in the Space Station orbit/inclination, while providing "order-of-magnitude" improvements in onboard computing power for science data processing and non-safety critical functions.

First demonstrated in 2009 on Hubble Servicing Mission-4, the first-generation processor—SpaceCube 1.0—has since evolved into a family of products that can meet nearly any spaceflight. All members of the product line-up—SpaceCube 1.0, 1.5, 2.0, and the SpaceCube-Mini—were developed with support from IRAD, the Satellite Servicing Capabilities Office, the Earth Science Technology Office and Defense Department funding. And all have flown or have been selected to fly on a variety of spaceflight missions, including the most recent Defense Department's Space Test Program-H4 mission deployed on the International Space Station.

"Not only has Tom innovated new products under the SpaceCube brand, he continuously looks for new applications, benefitting NASA, the U.S. military, and private research institutions. If anyone can find an application for this technology, it's Tom. We congratulate him for his success," Hughes said. ■

Above: This year's winner of Goddard's "Innovator of the Year" award, Tom Flatley, has played a pivotal role advancing Goddard's SpaceCube family of products. Shown here is the SpaceCube-Mini, along with two other devices that show the relative sizes of tiny satellites or Cubesats on which SpaceCube is slated to fly in the future. Photo credit: NASA/Goddard/Bill Hrybryk

ONE LAST LOOK AT GPM

By: Leslee Cork

The Global Precipitation Measurement mission will soon be leaving for Japan. Early next year, a Japanese H-IIA rocket will carry the GPM Core Observatory into orbit. GPM is an international satellite mission led by NASA and the Japan Aerospace Exploration Agency to measure rainfall and snowfall in all parts of the world every three hours. The core satellite carrying advanced instruments will set a new standard for precipitation measurements from space, unifying precipitation measurements made by an international network of partner satellites to quantify when, where and how much it rains or snows around the world.

leading up to the spacecraft's departure, the GPM Project Office and the Office of Communications worked collectively to organize several pre-ship events for GPM, the largest satellite ever built and tested in-house at Goddard.

The first of four events, GPM's Family and Friends Day, took place on Saturday, November 9. Depending on group assignments, attendees either began their day in the Earth Science Auditorium at the Visitors' Center receiving a mission briefing from project representatives followed by a tour in Building 29 or vice versa. Tour stops included the James Webb Space Telescope cleanroom, the Spacecraft Testing and Integration Facility and a viewing of the GPM core satellite . While at the Visitors' Center, guests also had the opportunity to browse the exhibit gallery, take an astrobiology walk and participate in hands-on activities. More than 250 GPM team members, their family and friends participated in the event.

On November 14, Goddard employees took one of twelve 30-minute GPM Employee Day tours. Attendees and their guests viewed the satellite, took photographs and discovered more about the precipitation-measuring satellite. A common question heard from participants was, "how does GPM get into the shipping container?" Like other spacecraft built in-house, Goddard has cranes to lift, tilt and gently place the satellite into the shipping container ensuring it arrives at its destination intact.

The culmination of the GPM pre-ship events took place on Friday, November 15 with Media and VIP Day. The morning event, for media, attracted more than 60 traditional and social media reporters, by far the largest turnout for such an event. After the presentation in the Earth Science Auditorium at the Goddard Visitor Center, media conducted one-on-one interviews with GPM project personnel before heading to the GPM cleanroom in Building 29. As the cleanroom door opened, though wall seems like a more appropriate description given its size, media were given the opportunity to get close—but not so close that they contaminated the cleanroom environment—to get photos and video for their respective outlets. Interested media were then taken to Building 28 for the Hyperwall experience. Presenters used the video wall, which consists of fifteen 46-inch high definition screens, to display Earth science simulations and animations on GPM, its scientific advances and societal benefits.

Capitalizing on the large media presence already at Goddard, attendees were invited to view the MAVEN press conference airing live from Kennedy Space Center at the conclusion of the GPM Media Day. In the afternoon, VIPs took time to see the spacecraft and learn more about GPM before the spacecraft is packaged inside the shipping container.

"My son had a great time thanks to your efforts and those of all the other Goddard folks," was one sentiment shared by an attendee from GPM's Family and Friends event. Other employees shared similar feedback as they left each event with smiles on their faces, memories in their cameras and a piece of their life's work launching into space. ■

Photo credit: NASA/Goddard/Debora McCallum

OUTSIDE GODDARD

By: Elizabeth M. Jarrell

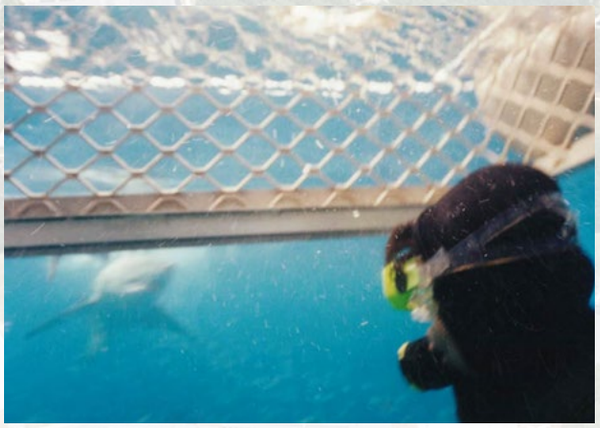
AROUND THE WORLD ADVENTURE TRAVELOGUE

Operations Researcher Param Nair is the Goddard representative for Joint Confidence Level assessments. Nair also leads the Flight Projects Directorate's cost estimating team tasked with developing and recommending best practices for projects in areas such as basis of estimates and work breakdown structure.

8° 30' 24" N/76° 57' 24": Born in Trivandrum, India. Operations Research Analyst Param Nair grew up in India, Singapore and Malaysia. His father was in the Indian Merchant Marine and later in shipping management in Malaysia.

27°59′17″N 86°55′31″E: A class trip included a visit to the Himalayan Mountaineering Institute. "People who physically achieve things are heroes to most kids," recalls Nair. "I was so inspired by the fact that these people pushed themselves to climb mountains."

41° 53' 51" N/84° 2' 14" W: Attended College in Michigan and South Carolina. Recalls Nair, "On the eve of my departure from Asia, my father gave me three bits of advice. First, study hard. Two, take care of your health. And three, travel as much as possible."



41° 42' 27" N/86° 53' 42" W: June 1992—Wreck dive in Lake Michigan. "The water was freezing and pitch black," recalls Nair. "Not every adventure is necessarily pleasant."

36° 3' 14" N/112° 8' 16" W: December 1996—Hiked to the bottom of the Grand Canyon. "On the way back, the trail was slushy with mud and ice, so I had to crawl," recalls Nair. "The best advice I got was from a Park Ranger who told me to look just to the next turn and not at the distant rim."

42° 49' 0" N/1° 38' 0" W: July 1999—Running with the bulls in Pamplona, Spain. "I was scared of the bulls but I was more scared of the other runners who were mostly drunk. The street was covered with sticky beer and broken bottles. There was only one way to go—with the crowd until it thinned out," Nair said.

3°4′33″S 37°21′12″E: December 1999—Nair climbed Mt. Kilimanjaro. "It's on the equator so there are no seasons. Kili is fascinating because it has five distinct climates and associated vegetation ranging from tropical plants on the bottom to snow and ice on the peak. You start at midnight to arrive at sunrise because if you happen to climb during daylight, you'd never want to attempt it. The last 200 feet was especially challenging because of low levels of oxygen and took longer than I expected. Sunrise on the top of Africa is exhilarating," said Nair.

While visiting the Serengeti, "I was in the tent one night. I heard a deep, guttural growling. The next morning I learned that five lions had walked through the camp. The armed guards had orders to shoot but only to prevent an imminent attack," said Nair. He also visited Lake Manyara and Tarangire National Parks in Tanzania. "I was fortunate to see 'the Big Five'—lions, elephants, leopards, cape buffalo and rhinos," said Nair.

34° 44' 0" S/135° 52' 0" E: July 2000—Nair began a yearlong tour around the world starting with swimming with the Great White sharks in Port Lincoln, Australia. Nair and another American were in a cage with bars all around except for directly in front, which was four inches of glass. Recalls Nair, "We attracted the sharks by chumming the water. One shark got excited and hit the cage. Being four inches apart from a man-eating machine was exciting!"

4°17′N 73°50′E: May 2001—Night scuba dive in the Maldives. "It was pitch dark except for our flashlights and it was truly a fascinating, if alien, environment," said Nair.

17°55′28″S 25°51′24″E: June 2001–August 2001—Backpacking across southern Africa. He saw a total solar eclipse in Mana Pools National Park, Zimbabwe. "The eclipse was in the mid-afternoon," remembers Nair. "Suddenly it became darker and colder. The birds stopped chirping. It lasted about 20 minutes. Mana Pools permits visitors to leave the vehicle and walk, so my guide and I followed a bull elephant." Then on to Victoria Falls. "It's a really beautiful spot about ten times the size of the Niagara Falls," he says. "At nearby Hwange National Park, it was a real treat to see two young bull elephants lock horns just in front of our vehicle."

31° 46' 48" N/35° 13' 48" E: September 11, 2001—In Jerusalem for a friend's wedding. Says Nair, "The irony was that my family was worried about my going to the dangerous Middle East."

39° 0' 15" N/76° 52' 32" W: July 2002—Began working at Goddard. "Within a month of coming to Goddard, I met my wife who is Japanese. Our kids are fluent in English, Malayalam and Japanese. Instead of swimming with Great White sharks, we go to zoos and aquariums," said Nair.

"When you're young, go for it," advises Nair. While waiting for his kids to grow old enough to travel with him, he hopes to write a travel chronicle based on his 76 albums of 28,000 photos and about 200 home videos. ■

Center: Nair and a great white shark off Port Lincoln, Australia. Photo provided by Param Nair