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The Earth Observer

Editor's Corner

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On February 16, NASA Administrator, **Michael Griffin**, appeared before the House of Representative's Science Committee to discuss the FY 2007 NASA budget. The proposed budget differs significantly from what was originally projected as the 2007 NASA budget when the FY 2006 budget was released. There are two reasons for the shortfall: 1) NASA received $170 M dollars less than it was originally projected to receive in its 2006 budget, and 2) projected costs for the Space Shuttle program were some $3-5 M dollars less than the program has actually cost. NASA has decided to fully fund the Shuttle Program in pursuit of fulfilling *The Vision for Space Exploration* and, as a result, must make cuts to other areas to make up for the cost overruns.

The proposed FY 2007 budget will, therefore, shift funds from Science and, to a lesser extent, Exploration to fully fund the Shuttle Program through 2010. Griffin stated that, "*My decision to curtail the rate of growth for NASA's Science missions is not intended in any way to demonstrate a lack of respect for the work done by the NASA Science team*." In fact, the proposed Science budget for 2007 is still 1.5% greater than it was in FY 2006, but substantially less than the levels that were projected when the FY 2006 budget was released. Research and Analysis across the entire Science Mission Directorate (SMD) will bear the brunt of the cuts.

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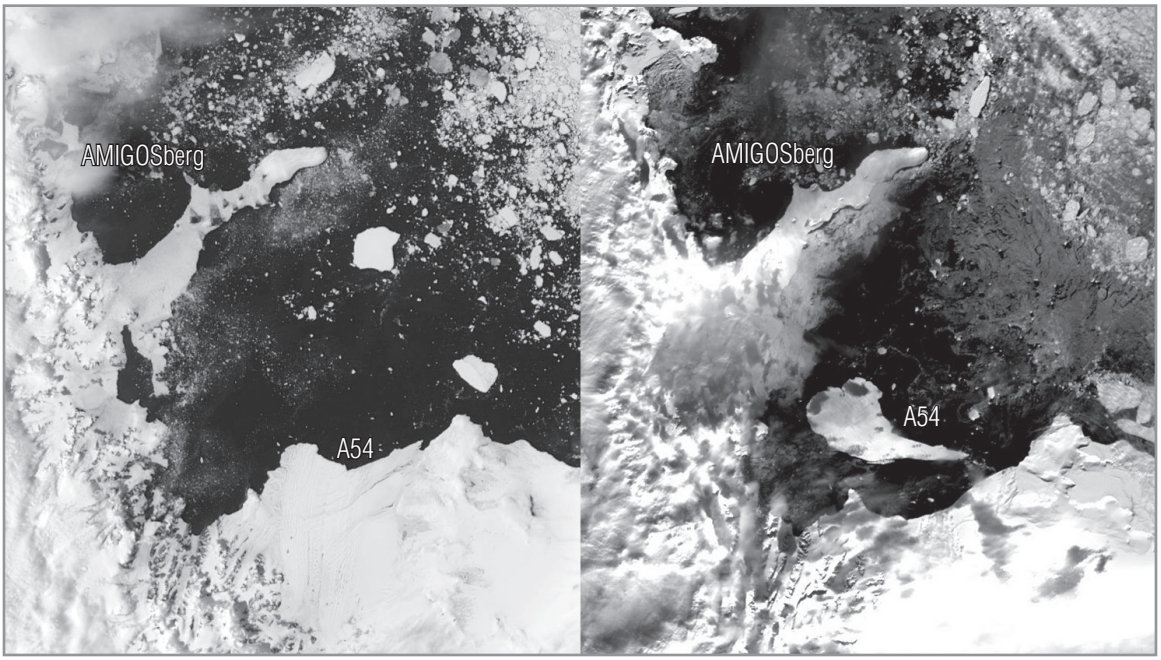
In March 2006, a team of researchers from the United States and Argentina visited an iceberg near the Antarctic Peninsula and set up weather instruments, snow sensors, and a video camera on its surface. The iceberg, nicknamed AMIGOSberg, will take the equipment along on its journey northward into warmer waters, and the sensors will send the data they collect to the scientists via satellite. The Moderate Resolution Imaging Spectroradiometer (MODIS) flying onboard the Aqua and Terra satellites captured these images of AMIGOSberg and its surroundings in early 2006. Aqua took the picture on the left on February 7, and Terra took the image on the right on March 5. Besides capturing AMIGOSberg's northeastward drift, the images also show the breaking off—*calving*—of a new iceberg, A54, near the bottom of the image. Images courtesy of Terry Haran, National Snow and Ice Data Center, using data from NASA MODIS and Aqua.



In This Issue

On March 2, 2006, Mary Cleave, Associate Administrator for Science, testified before the House Committee and gave more details on the planned 2007 SMD budget. Cleave stated that, "*NASA faces significant challenges and opportunities in implementing a robust and exciting Science program. In a time of constrained resources and a large number of compelling future Science missions, setting priorities is more important than ever. NASA is committed to undertaking the necessary prioritization studies in a joint activity with the science community via the National Academies and NASA's advisory committee apparatus.*"

The SMD has been reorganized and will now have four science divisions: Astrophysics, Earth Science, Heliophysics, and Planetary Science. The most significant change in this new structure is that it divides the former Earth-Sun System Division into two divisions: Earth Science and Heliophysics. This change provides added visibility for NASA's Earth Science activities and better reflects the work being done in these two distinctly different disciplines.

With regard to Earth Science, the FY 2007 budget request is $1,530.7 million. With the Earth Observing System initial series of satellites now deployed, the focus is on exploiting EOS data in research, modeling, and applications, and on defining, formulating and implementing successor and complementary missions. For future missions, the largest challenge remains the delivery of instruments for the National Polar Operating Environmental Satellite System (NPOESS) Preparatory Project (NPP). In anticipation of development of a new baseline for NPOESS by the tri-agency Integrated Program Office, NASA has moved the NPP launch date to April 2008; further change is probable as NPOESS rebaselining is still in process.

Meanwhile, in the realm of flight missions, the Ocean Surface Topography Mission (OSTM) confirmation review was conducted in February. The Glory mission has also been confirmed to proceed to implementation as an independent satellite mission—rather than hitching a ride on vehicles intended for other purposes. Launch of the Global Precipitation Measurement (GPM) mission is delayed to the end of 2012. NASA and the U.S. Geological Survey (USGS) received revised guidance from the Office of Science and Technology Policy (OSTP) in December 2005 on Landsat, and NASA is proceeding with planning for the acquisition of a Landsat Data Continuity Mission, also as a free-flyer. In parallel, OSTP will work with NASA, USGS, and other agencies on a strategy for operational land observation.

The Earth System Science Pathfinder (ESSP) missions, Orbiting Carbon Observatory and Aquarius, have been confirmed to proceed to implementation. The ESSP backup mission Hydros was not confirmed. The release of the next ESSP Announcement of Opportunity will be no earlier than FY 2008. NASA has formed a joint working group with NOAA to plan the transition of NASA research results and observing capabilities to future NOAA operational systems, and will report on its progress as requested by the Congress. NASA also eagerly awaits the release of the National Academy of Sciences Decadal Survey report this fall as a guide for planning for future Earth Science missions.

I would like to announce that **Christopher Shuman** has stepped down as Deputy Project Scientist

of ICESat. Shuman works as a glaciologist at NASA Goddard's Cryospheric Sciences Branch, and has served as the ICESat Deputy Project Scientist since 2001. His research emphasis is on ice sheet, ice cap, and outlet glacier elevations and elevation change, and the role of these ice masses in the global climate system. His work has recently centered on ICESat altimetry data but he has also conducted passive microwave and IR studies of ice sheet temperatures, primarily in support of ice core operations in central Greenland (GISP2) and at Siple Dome, Antarctica. Shuman is an Adjunct Professor at the University of Maryland's Earth System Science Interdisciplinary Center and supports graduate students at other institutions as well. I would like to extend my sincere thanks to Shuman for his years of faithful service.

I'm pleased to report that **Robert Wolfe** is now serving as Deputy Project Scientist for Data for Terra. Wolfe has a background in geolocation and computer science, has played a key role in the MODIS data processing activities, and has led the EOS Data Systems Working Group in areas of Long Term Archiving and Data Access and Usability. His expertise in data issues will complement the science strengths of Terra Project Scientist Marc Imhoff and Deputy Terra Project Scientist Si-Chee Tsay. Wolfe will help guide the evolution of the Earth Science Data Information System (ESDIS) and play a key role in ensuring data system resources are available for fusing data from multiple instruments.

As reported above, the Glory mission has been confirmed to proceed toward implementation and a planned 2008 launch. Glory will become part of the Afternoon Constellation of Satellites, flying three minutes behind Aqua in the formation, and supporting the objectives of the U.S. Climate Change Science Program by continuing and improving upon long-term monitoring of two key forcings that influence global climate: aerosols and total solar irradiance. I wish to recognize **Michael Mishchenko** of the NASA Goddard Institute for Space Studies (GISS), who is serving as Project Scientist for Glory. Mishchenko is well-qualified for the job, having a background in radiative transfer, electromagnetic scattering, and satellite remote sensing. He has previously been a recipient of the Henry G. Houghton Award of the American Meteorological Society and an elected Fellow of the American Geophysical Union, the Optical Society of America, and the Institute of Physics. Mishchenko also served as Topical Editor and Editorial Board member of several leading scientific journals, and previously served as the Project Manager for the NASA/ Global Energy and Water Cycle Experiment (GEWEX) Global Aerosol Climatology Project.

In other news, I'm pleased to report that the Boeing machinist's strike that had been holding up the launch of the CloudSat/Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) mission since last fall has been settled and the launch is now scheduled for April 20.

ICESat began its ninth period of laser operations with the firing of Laser 3 on February 22. This ops period should last for about 45 days, repeating the standard set of 33-day ground tracks plus about 12 days of ground tracks not covered before. Among other measurements, this will provide the fourth year of mapping of Arctic sea-ice freeboards and ice-thickness.

Lastly, Aura continues to perform well. The Costa Rica Aura Validation Experiment (CRAVE) is underway. Planning is also underway for the Intercontinental Chemical Transport Experiment (INTEX). The Tropospheric Emission Spectrometer (TES) is now back on line and the Science Team is pleased with the results. To preserve the instrument's lifetime, TES is currently operating only in the nadir mode except for special observations such as those planned for INTEX. ■

Edward Goldstein, a NASA employee who is also a Ph.D. student at George Washington University in the Department of Public Administration, is writing a dissertation on the history of NASA's Earth Observing System. He would like to interview EOS professionals who might be able to shed insight into how EOS fits into the history of "big science" programs and into the NASA mission and culture. If you would like to participate in this research please contact Edward at: *edgold18@comcast.net*.

Switch Maneuver of GRACE Satellites

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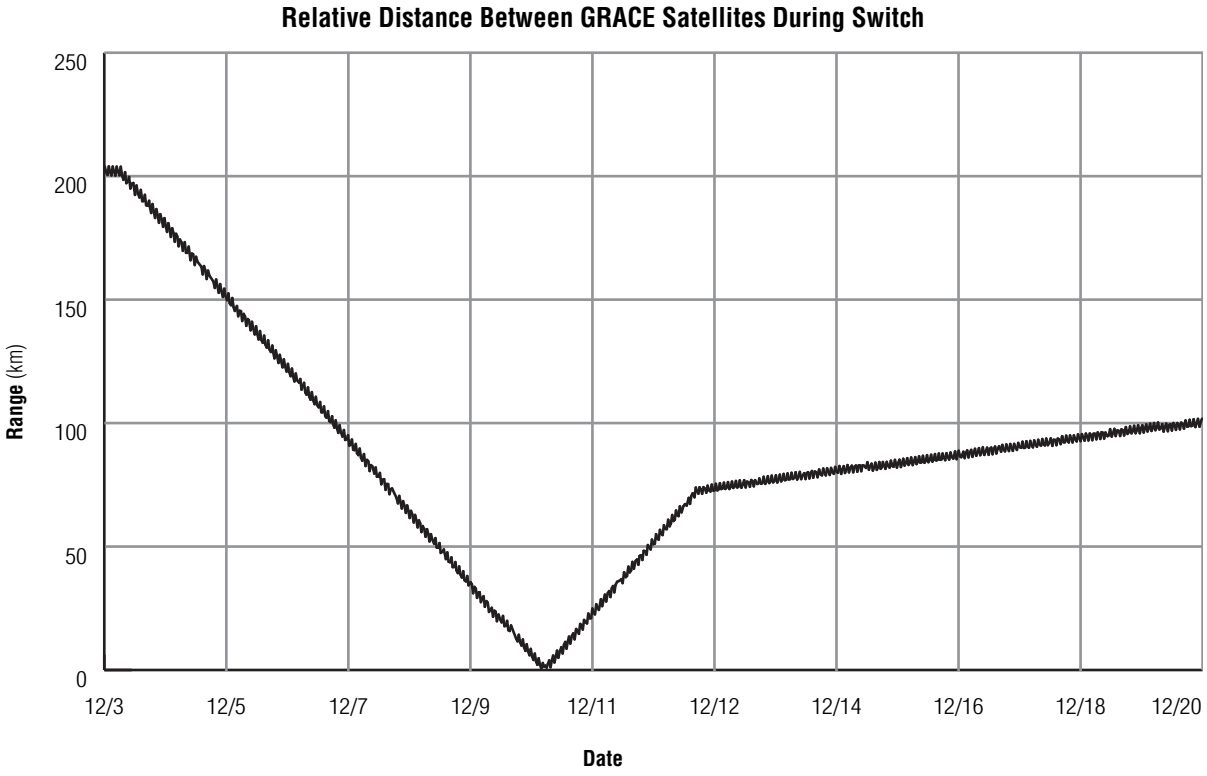
The Gravity Recovery and Climate Experiment (GRACE) was launched in 2002 and continues to make detailed measurements of Earth's gravity field which are leading to new discoveries about gravity and Earth's natural systems. GRACE does not carry a suite of independent scientific instruments. Instead, the twin GRACE satellites act in unison as the primary science instrument. The K-Band ranging system (KBR) can detect instantaneous extremely small changes in the distance between the two satellites and use this information to make gravitational field measurements with a level of precision never before possible.

Since launch, the trailing satellite (GRACE-2) has been flying forward with its K-Band antenna horn exposed to the impacting atomic oxygen. There is some risk that overexposure to atomic oxygen could lead to a loss of thermal control over the K-band horn, which would affect the accuracy of the KBR signal. To ensure uniform aging and exposure for the K-band antennae on each of the satellites, the GRACE team has been planning a switch of the two satellites around the middle of the mission so that the trailing satellite would become the lead satellite. During this maneuver the trailing satellite had to cross the path of the leading satellite and take over the lead position.

The GRACE team analyzed the relative motion of each satellite and selected December 10, 2005, as an optimum time to perform the switch maneuver that would allow for a minimum risk of a collision at the point of closest approach (CA). The maneuver was carefully planned so that the two satellites could not get any closer together than 300 m—they actually never got any closer than 406 m at CA. **Table 1** summarizes the highlights of the switch maneuver and details what was going on with each satellite during the process.

Note that the switch was accomplished with only three Orbit Thrust Maneuvers (OTMs). In truth, the switch could have been accomplished with only two OTMs, but the GRACE science team wanted to take advantage of the opportunity to examine the science benefits of having the two satellites flying closer together (~100 km apart), and hence a third OTM was needed a month later to move the satellites back to their "normal" distance. OTM-1 took place on December 3, 2005, and the two subsequent maneuvers (OTM-2 and OTM-3) occurred respectively on December 12, 2005, and January 11, 2006. The maneuver was a success and GRACE-2 is now the leading satellite. **Figure 1** and **Figure 2** provide graphical illustrations of how the range between the two satellites changed during the switch.

Figure 1: This graph shows how the relative distance (range) between the two GRACE satellites changed over time, starting from the day of the first orbit thrust maneuver (OTM-1) on December 3rd to initiate the satellite switch.



Additional technical background on the switch of the GRACE satellites can be found at *www.csr.utexas.edu/grace/operations/switch_maneuver.html* that may be of interest to some readers. ■

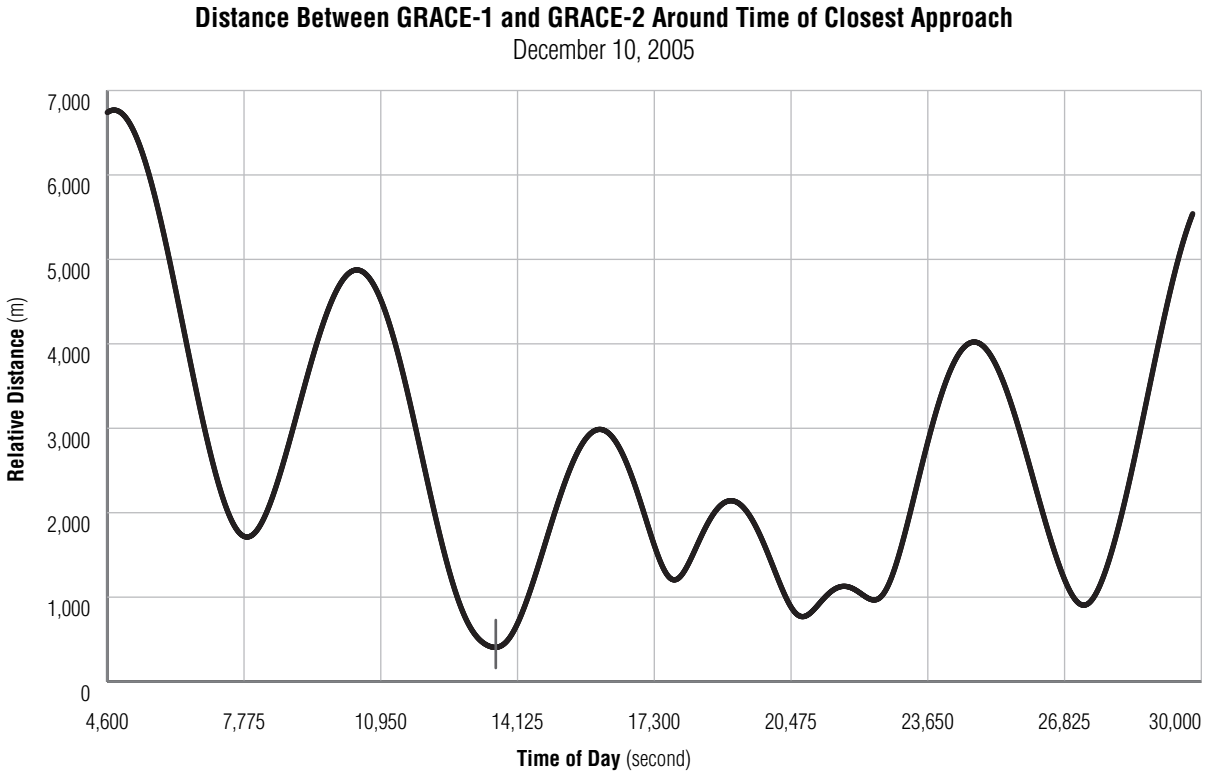


Figure 2: This figure shows the scalar distance between the two GRACE satellites around the CA event, which is marked by a line at about 13,600 seconds—about 03:47 UTC on December 10, 2005. The distance between the satellites at CA was about 406 meters.

Table 1: Highlights of the GRACE swap maneuver. Credit: Joe Beerer, NASA Jet Propulsion Laboratory.

Date	Day	Event	GRACE-2	GRACE-1	Range (km)*
December 3, 2005	Sat	OTM-1	Yaw 180° (Yaw bias=180) Execute Burn (688 sec; -10.88 cm/sec) Near the South Pole Yaw 180° (Yaw bias=0)		-203 (29 km/day)
December 9, 2005	Fri		Yaw 180° (Yaw bias=180) For KBR Receiver safety (link breaks)		-29
December 10, 2005	Sat	CA	At 03:47 UTC. GRACE-2 passes GRACE-1 and becomes the leading satellite		0
December 11, 2005	Sun			Yaw 180° (Yaw bias=0) Re-establish KBR link	29
December 12, 2005	Mon	OTM-2	Yaw 180° (Yaw bias=0) Execute burn (611 sec; +9.82 cm/sec) Yaw 180° (Yaw bias=180)		58 (3.3 km/day)
January 11, 2006	Wed	OTM-3	Yaw 180° (Yaw bias=0) Execute Burn Yaw 180° (Yaw bias=180)		170 (0.5 km/day)

*numbers in parentheses indicate drift rate for the satellites

Firsthand Accounts of the JASON Argonaut Experience

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Marjorie Sparks, margie.sparks@verizon.net, Teacher, St. Hughs School, Greenbelt (JASON XVII Teacher Argonaut)

The JASON Project is named after the mythological Greek adventurer, Jason, and is a nonprofit subsidiary of the National Geographic Society. Robert Ballard founded the JASON Project back in 1989. (Ballard is best known for his discovery of the *RMS Titanic* shipwreck.) JASON provides multimedia science curriculum and professional development to one-million middle-grade students and 20,000 teachers in 41 states and around the world. The program's use of telepresence technology to connect students with real scientists is unique in education. JASON's mission is to improve the way science is taught by allowing students to learn directly from leading scientists and engineers. JASON is widely recognized for its power to teach difficult concepts and to excite and engage students of diverse learning styles.

Through generous support from various sponsors including NASA, the JASON Program helps to equip students with the skills they'll need for the 21st Century marketplace and also inspires the next generation of scientists and explorers. Since 1989, JASON Expeditions have involved students and teachers in research that transports their minds and imaginations (and sometimes even the students and teachers themselves) to some of the most exciting places on Earth—even to the very outer limits of our solar system. Each JASON Expedition curriculum aligns closely with textbooks and engages students of different levels of learning. Independent evaluations confirm that JASON's multimedia science curriculum positively influences student's perceptions of scientists and helps them grasp a deeper understanding of complex science concepts.

The January-February 2006 issue of *The Earth Observer* included a summary of the most recent JASON XVII Expedition: *Mysteries of Earth and Mars*. Middle-grade students across the country learned Life, Space, Earth, and Physical Sciences by comparing the planetary environments of Earth and Mars. Working with NASA scientists and the latest Mars rover research, JASON students are investigating *Mars analogs*—locations on Earth where environmental conditions, geologic features, or biologic attributes resemble in some way those thought to exist on Mars, now or at some point in the past. In addition, JASON students are examining how engineers designed and built the Mars rovers, *Spirit* and *Opportunity*, to explore the Red Planet.

Now *The Earth Observer* is happy to present two firsthand accounts of the JASON experience, one from the point of view of a student and one from the point of view of a teacher. These accounts give us a sense of what it's like to actually participate in a JASON expedition.

A Student's Perspective

Megan Shaffer *had an opportunity to participate in the* Mysteries of Earth and Mars *expedition last year, one of three such expeditions she participated in while she was a student at St. Hugh's School in Greenbelt, MD. Shaffer is currently a freshman at Elizabeth Seton High School in Bladensburg, Maryland and, perhaps spurred on by her experiences with JASON, has aspirations to become a marine biologist when she gets older. Shaffer shares a personal account of her experiences below.*

In the past year, I was given the once in a lifetime opportunity to be an Argonaut for the JASON XVII Expedition: *Mysteries of Earth and Mars*. During the summer, I traveled to Milwaukee, Wisconsin for *Argo Boot Camp*. There, I met the eleven other Student Argonauts and four Teacher Argonauts. In Milwaukee, we did a variety of activities, from using a Texas Instruments calculator and probes to take measurements and observations, to going snorkeling in a quarry. The first day, we learned about the research project that we would be studying for the next six days. We were going to explore the *window of opportunity* for life for zebra and quagga mussels in Lake Michigan. We visited a pond to see what kind of wildlife lived in swampy conditions.

The second day, we snorkeled at a quarry that had just recently become filled with water. It was so recent that when you snorkeled, you could still see a road, road signs, and trees underwater. It was odd to see fish

Tufa towers at Mono Lake.

Megan Schaffer and a scientist prepare for the broadcast.

swimming among these submerged landmarks. It was interesting to learn that the fish we saw in the quarry or their eggs might have been dropped there by birds. After snorkeling, we went canoeing, which was very difficult considering Milwaukee was in a mini drought. We had to paddle through very shallow water and at times carry our canoes. Then we took a research vessel to two different parts of Lake Michigan to conduct research on the mussels. We concluded our research and found that these mussels needed a certain amount of dissolved oxygen, food, and turbidity in the water, as well as a certain pH, and water temperature to survive. We compared these results to what we could expect the *window of opportunity* to be for Mars. After our week of boot camp and research, we were assigned certain expedition sites to continue our research on life on Mars—a *Mars analog*. The four expedition sites were NASA's Jet Propulsion Lab in California, Meteor Crater in Arizona, Mauna Loa volcano in Hawaii, and Mono Lake in California. At the end of the week in Milwaukee, I was chosen to go to Mono Lake, California to study organisms in extreme conditions with JASON host researcher, Jack Farmer.

I went to California for five days in September with a Teacher Argonaut, Danielle Renz, and two other Student Argonauts, Andrew Young and Meera Gudavalli. Each day we would hike down to the lake by walking through old tufa towers, sagebrush, tall grasses, and trees. After getting to the lake, we studied the extreme conditions that exist there. The lake is a *terminal lake*, which means that it has freshwater springs running into it, but no way for water to exit the lake, which makes it very salty. Mono Lake has a very high alkalinity, having a pH of 11, and is extremely saline, which makes it hard for organisms to survive in the lake. We learned that the only two organisms that lived there are the brine shrimp and the alkali fly. We also learned about the formation of the large rock structures, called *tufa towers*, large formations that come up out of Mono lake and are created by underground springs mixing with saline and alkaline lake water.

Our first day at Mono Lake began at the Mono Lake Visitor Center (MLVC). Jack Farmer gave us a lecture about the history of the lake. He explained that the lake formed from glacial melting. From the MLVC, you can see the beautiful scenery of Mono Lake and the chain of inactive volcanoes surrounding it. We watched a movie about Mono Lake in the visitor center and looked at the exhibits. After completing our visit to the MLVC, we hiked down to the north side of Mono Lake.

We studied the famous Mono Lake tufa towers in detail. The towers are composed of calcium bicarbonate, or limestone, which adds to the alkalinity of the lake. To understand the geological processes involved with the formation of the tufa towers, we studied one that was formed in glacial water during the Pleistocene period, millions of years ago. In order for us to look more closely, Jack Farmer removed a small piece of the tufa tower with a hammer. We saw crystal formations on the piece of tufa, and concluded that the tufa towers grew slowly in colder temperatures. However, the more-

From left to right: Meera Gudavalli, Danielle Renz, Megan Shaffer, and Andrew Young, with our waders getting ready to explore Mono Lake's tufa towers.

From left to right: Andrew Young, Meera Gudavalli, Megan Shaffer, and Danielle Renz, having fun in our chest waders before we go out to take measurements of Mono Lake.

recent tufa towers did not have crystal formations, but rather rounded rock formations. On these, we found biofilms, and later learned that microorganisms lived on these tufa towers. Both kinds of tufa towers had *biosignatures*, or fossils, on them. This helped us determine how old they were.

After studying tufa towers, we studied the extreme conditions and organisms of the lake. At the shore, we put our hands in the water and it felt slimy, almost like soapy water. We also tasted it and it was very salty. Jack Farmer led us out into the water where we took water samples and measured the salinity, pH, dissolved oxygen, temperature, and turbidity. Despite the extreme conditions in the lake, I was amazed to see that some organisms could survive in the lake. The first form of life we saw were the alkali flies, which were unnoticeable until disturbed. These flies spend two-thirds of their life underwater in pupa cases. After coming out of their case, they only return to the water to reproduce and eat. When they reproduce, they enclose themselves in a bubble and travel to the tufa towers to lay their eggs. There were millions of these flies around the lake, and if you listened closely, you could hear their faint buzzing. These flies have been seen up to 50 feet deep in the lake.

The only other living organism that lived in the lake were the clear brine shrimp, or *sea-monkeys*. These very small brine shrimp serve as food for the migratory birds. The lake almost looked like brine shrimp soup because there were millions of them in the lake. The brine shrimp eat the dissolved biofilm substances in the lake water. Mono Lake serves as a perfect resting spot for many migratory birds, not only because of the shrimp, but also because of the peaceful habitat. There are also many places of shelter for the birds.

After studying Mono Lake, we compared this data to what life could be like on Mars. We determined that if organisms could survive in the extreme Mono Lake, then possibly organisms could also survive in the extreme conditions of Mars. We learned what was absolutely necessary for life, hoping that this would help us with research on Mars. Jack Farmer believes that there may have been similar conditions to Mono Lake on Mars in the distant past. If scientists discovered tufa towers on Mars, the tufa towers might suggest that life once used to be there. I hope that NASA's rovers, *Spirit* and *Opportunity*, continue to explore Mars and give us evidence that Mars once supported life.

After our Mono Lake Team was done with the research we had a free day to explore the scenery in California. We went swimming in Mono Lake. The lake was very cold, but it was so awesome to be able to float in the water because of all of the salt. We also went horseback riding through trails in the woods and through water. We went hiking up the side of a volcano searching for obsidian, or volcano glass. These shiny black rocks were everywhere you looked. At the end of the day, we went and relaxed in hot springs. Then after a long week at Mono Lake, we sadly headed back to the hotel and reflected on what a great trip we had.

In January and February, the JASON Expeditions were broadcast to various sites in the United States and Mexico. I went to my Primary Interactive Network (PIN) site, NASA Goddard Owen Science Center, and during the broadcast, I had a live call in to Robert Ballard, founder of the JASON foundation. After the broadcast, I explained to the students about my wonderful experience at Mono Lake, and encouraged all of them to apply for next year's JASON Expedition.

I had such an amazing time in Milwaukee and California. When I filled out the application to become a JASON Argonaut, I never imagined that I would have such an incredible experience. I've done things that I never dreamed of doing in my life, like flying in a plane, snorkeling on what used to be a road, meeting so many wonderful people, and floating in Mono Lake. I am disappointed that it had to come to an end, but I keep in touch with all of the student and teacher Argonauts online on the JASON Message Boards. The JASON Expedition was a life-changing experience that I will never forget.

A Teacher's Perspective

Margie Sparks *is a teacher at St. Hugh's School. She teaches science and social studies to sixth, seventh, and eighth graders.* The Knights of Columbus *(a Catholic fraternal organization) recently named Sparks the Catholic School Teacher of the Year for the state of Maryland. Sparks participated in the Jason XIV:* From Shore to Sea *expedition in 2003. In* From Shore to Sea, *expedition participants examined the unique and dynamic aquatic systems that extend from California's coast to the Channel Islands National Park and National Marine Sanctuary. Teachers and students learned about the giant forests, northern elephant seals (pinnipeds), the island fox, island formation, Earth systems, plate tectonics, and Chumash Native American culture. Sparks shares a personal account of her experiences below.*

My experiences with the JASON Project began in 1994 with the JASON VI Expedition: *Island Earth* that studied Hawaii. I had been looking for a neat way to do science with my students, using more hands-on activities, and this seemed perfect. I was a little concerned about the suggested use of computers with my students; I didn't know all that much about technology and wasn't really comfortable with using it in the classroom. Nevertheless, I bit the bullet, started with small steps, adapted when things didn't go as planned, and before I

knew it, my students and I were hooked.
One of the exciting things about the JASON Project is the opportunities it offers for students and teachers to get involved. The Argonaut program is one such opportunity. I applied in 2002 to become a Teacher Argonaut for the JASON XIV Expedition: *From Shore to Sea*. After submitting all my paperwork (application, essays, release forms, etc.) I went on about my everyday life. After all, I teach at a small parochial school in Maryland, and I knew there was a lot of competition from other, more-accomplished educators. So, you can imagine my surprise when I received a call from the coordinator of the Argonaut program. She was arranging a time to come interview me and observe me in my classroom. I was so nervous, but I had a lot of support from my Primary Interactive Network (PIN) site, my principal, my colleagues, and my students. When I received my acceptance letter, I was overjoyed. I had done it; little did I know that my adventure was just beginning.

It is very difficult to describe my experiences as a Teacher Argonaut to anyone who has not gone through it. The experience was one of the best, most exhausting, exciting, most fulfilling times of my life. The new Teacher Argonauts were told that we would be beginning our work right away, even though it was April and our expedition wasn't until the following January. We began with conference calls, introducing ourselves, and getting our first assignment, which was to read over the Student Argonaut applications and conduct telephone interviews with the applicants. We also needed to get ready to travel to Milwaukee for the National Educator's Conference, our one and only opportunity to meet as a group and receive our Argonaut training.

The trip to Milwaukee was busy; there is no down time with JASON except when you sleep. My fellow Teacher Argonauts are wonderful, supportive educators, and we all bonded right away. It was a busy week with classes, meetings, and activities. Then it was time to go home, continue working with the curriculum, keep up our communication with each other, and with our Student Argonauts. These students are fantastic; they juggled their school work and extra curricular activities as well as their JASON assignments. They were a joy to work with.

Finally, it was time for our expedition. Argonauts were sent to either Anacapa Island or Santa Barbara. I was assigned to Santa Barbara and worked in the Maritime Museum there. It was an amazing experience. Our day began at 4:45 A.M., when we gathered for our walk from the hotel to the museum restaurant for breakfast and our daily briefing. Then we gathered in our room in the museum to plan the day, focusing on what would be covered during that day's broadcast, our assignments, and our journal entries.

We did four one-hour broadcasts each day; the first broadcast of the day was at 7 A.M., with a half-hour between each broadcast. At first it didn't seem as if that was enough time to complete everything we needed to do between broadcasts, but by the end of the expedition, I was amazed at what could be accomplished in half an hour. Our sound and film crews were amazing; they helped us out, gave us tips to make things flow easily, explained their jobs and how their equipment worked, and generally took us under their wings, showing endless patience with us.

Another highlight of the expedition was working directly with the scientists and learning and using the technologies they use. Our host researchers were fantastic people, patiently sharing their knowledge, time, and expertise with all of us. We received an in-depth understanding of infrared sensors, how to use them, and what kind of information we could gather. Remote sensing was a big part of our expedition, both using the infrared sensors and the remotely operated vehicles (ROVs) Robert Ballard is known for. Operating an ROV effectively is harder than it appears, although I did find out through personal observation and experi-

Marjie Sparks in front of the bay in Santa Barbara.

Student & Teacher Argonauts hard at work between broadcasts at the Santa Barbara Maritime Museum.

Top: This is a view of the California Channel Islands from Inspiration Point on Anacapa Island.

Middle: A group picture of the Student Argonauts, Jude Kesl, and me at Inspiration Point.

Bottom: St. Hugh's School eighth-grade student Sarah Layton working on a NASA experimental plane. This was part of St. Hugh's mission researching the diverse ecosystems of the Chesapeake Bay for NASA's RSESTeP program. Also in the picture guiding Sarah are Allen Lunsford and Sallie Smith from NASA.

ence that our younger generation, raised with video games, seems to have a distinct advantage over someone my age. We had a dive tank with a doll in SCUBA gear (he was called *SCUBA Steve*) and an ROV in it. The controls and operating screen were over to the side. Our task was to rescue *SCUBA Steve* by grasping him in the claws of the ROV and bring him to the surface. After many of my carefully orchestrated attempts to rescue *Scuba Steve* resulted in his air tanks being ripped off each time, I admitted defeat. One of my Student Argonauts then made an attempt, and on his first try, successfully delivered Steve to the surface. That one was hard to live down. We also spent time learning about the Chumash Indians and their culture. We made instruments and jewelry as the ancient Chumash did and learned some of their fables.

After our last broadcast each day, we proceeded to other activities. Each day brought a different activity. We had a luau on the beach with all of the week-one and week-two Teacher and Student Argonauts, researchers, and crews together. Those of us at Santa Barbara were able to travel to Anacapa Island and experience the science going on there. Anacapa is an isolated, beautiful place with a lot of ongoing research. As we hiked the island, I stopped at *Inspiration Point*, and being a typical tourist, I took a picture that provides the background on my computer today (see top photo at left). Without fail, everyone who sees it, asks where it is and talks about how cool it would be to go there someday. I get to tell them I have been there, and I took that picture. That always leads to being able to relate my JASON experiences, which I tend to do until I notice their eyes glazing over.

We also learned how to surf while we were there. Some of the students had never been to a beach before, and their delight in this experience is a memory I will treasure forever. I also took the students on a surrey bike ride on the beach. It was four to a bike, and of course, the inevitable race occurred. By the time we arrived at the hotel that evening, around 8:30 P.M., the Student Argonauts were begging to go to sleep; they were exhausted.

All too soon, the expedition was over. Goodbyes were hard to say, and we all promised to keep in touch. I still have contact with some of the Teacher and Student Argonauts and enjoyed getting reacquainted with them at an Argonaut reunion a few years later.

As I said earlier, it is difficult to describe my experiences as a JASON Teacher Argonaut. Even though I was exhausted when I got home, I would go again in a heartbeat. I feel a personal connection to Santa Barbara and Anacapa Island. They are my special places, and I miss being there. One of my Student Argonauts was on Anacapa Island for the expedition, and she cried on the way home. She said she was going to miss her stars on her island. I have continued my involvement with JASON. I teach each new JASON expedition to my students, I am on the JASON Teacher's Advisory Council, and I help train teachers in my area to use

JASON. As a result of my experiences, I applied and was accepted with sixteen other JASON teachers across the nation to be a part of the NASA sponsored Remote Sensing Earth Science Teacher Program (RSESTeP) that allowed me to bring NASA's cutting-edge technology to my students while we conducted a mission on the diversity of the Chesapeake Bay.

My JASON experience has opened a world of opportunities to me, both personally and as a teacher. I cannot imagine the effect an Argonaut experience has on a fourteen-or-fifteen-year-old student. JASON is a wonderful program, and my experiences as an Argonaut have changed my life. I regularly use technology now in my classroom and incorporate hands-on activities throughout my curriculum. I am more confident in my ability to seek new opportunities and experiences for me and my students. Three of my students have been selected as Student Argonauts on different expeditions and have come back to share their experiences with my younger classes. The JASON Program changes lives, and I am so blessed to have had this experience.

To learn more about The JASON Project's standards-based science curricula and professional development, visit www.jason.org *or call 1-888-527-6600.*

Kudos

Each year, the President recognizes a small group of Senior Executives by awarding them the President's Rank Award for exceptional accomplishments. This prestigious award recognizes "strong leaders, professionals, and scientists who achieve results and consistently demonstrate strength, integrity, industry, and a relentless commitment to excellence in public service."

The following EOS colleagues were presented the 2005 Presidential Rank Award for Meritorious Senior Professional:

Mark Schoeberl, Aura Project Scientist, NASA Goddard Space Flight Center
Jim Garvin, Chief Scientist, NASA Goddard Space Flight Center

The following individual was awarded the 2005 Presidential Rank Award for Distinguished Executive:

Edward J. Weiler, Center Director, NASA Goddard Space Flight Center

The Earth Observer staff, on behalf of the entire scientific community, would like to congratulate these colleagues on this outstanding accomplishment.

January 2006 MODIS Science Team Meeting Overview

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The twenty-sixth Moderate Resolution Imaging Spectroradiometer (MODIS) Science Team Meeting was held January 4-6, 2006, at the Radisson Plaza Lord Baltimore hotel in Baltimore, Maryland. The number of people who registered for the meeting was 249. A summary of the meeting follows. Readers are encouraged to get more detailed insight into the meeting content by reviewing the presentations and meeting minutes available at: modis.gsfc.nasa.gov/sci_team/meetings/200601/index.php.

January 4

The Science Team meeting began with an opening plenary session composed primarily of presentations by NASA Headquarters Focus Area Leaders.

Vince Salomonson [NASA Goddard Space Flight Center (GSFC)—MODIS Science Team Leader] began the meeting by expressing appreciation for all those attending. He noted that everyone could expect some very substantive results during the course of the meeting in the many presentations in the plenary and discipline group sessions along with approximately 100 posters that had been prepared. The primary intents and purposes of the meeting were to gain an assessment of the progress being made in using MODIS for science and applications, making plans for continued progress, and preparing for upcoming NASA proposal opportunities that will define the character of MODIS-related research and activities in the future. As the meeting progresses it will be particularly important to examine the efforts of the Team in the light of the evolution from *missions* to *measurements* in the NASA Earth Sciences programs.

Salomonson reported that the MODIS instruments on the Terra and Aqua spacecraft are performing nominally. MODIS data-processing systems are doing well. The GSFC Distributed Active Archive Center (DAAC) is delivering Level 1 products consistently and staying very close to real-time. The MODIS Data Processing System (MODAPS) is also doing quite well with forward processing about one day behind real-time. *Collection 5* processing of MODIS atmospheres products is about to begin and the *Collection 5* processing of land products will begin sometime in the spring. The Ocean Biology Processing Group (OBPG) is doing well in processing and disseminating Aqua oceans products and will eventually assume Terra MODIS processing starting with sea-surface temperature (SST) products.

The recent NASA Headquarters Earth Science Senior Review has approved Terra for an extended mission into 2009. Salmonson expressed thanks to Jon Ranson, who served for many years as the Terra Project Scientist and who led the proposal and presentation efforts. He also announced that Mark L. Imhoff has been appointed recently as the new Terra Project Scientist.

Salomonson noted that it is hard to effectively and comprehensively convey the successes being derived from MODIS observations, but the MODIS data are being used very extensively. As a "metric" of the extent of MODIS use, the Web of Science publication and abstracts listing shows a total through 2005 of 973 refereed MODIS-related publications, 319 of which were in 2005 alone versus 181 in 2004—i.e., a rapid growth in the last two years. At least 200 MODIS presentations occurred at the 2005 Fall American Geophysical Union (AGU) meeting. The expectation is that results will continue to grow as the MODIS database that now stands at 6 years of Terra MODIS and 3.5 years of Aqua MODIS continues to grow and as products improve though reprocessing, etc.

Paula Bontempi [NASA Headquarters—MODIS Program Scientist] welcomed everyone and expressed appreciation for their attendance and preparations for the meeting in terms of papers and posters. She reviewed the agenda for the meeting and noted, in particular, that the meeting would begin with the plenary sessions in which representatives from NASA Headquarters will talk about focus areas, key science questions and measurement needs. She expressed appreciation for these Program Managers taking the time to provide these presentations in that they will give all attendees, including the MODIS Science Team, insight into the various focus areas and activities into which MODIS Science Team efforts can now and in the future be expected to make considerable contributions. For example, the EOS Data and Information System (EOSDIS) evolution is occurring in support of measurements needs and application sciences national needs. There will be a poster session and the afternoon session will discuss MODIS science and application highlights. Day two will be the group discipline sessions, and day three will be a wrap-up plenary session.

The morning plenary session continued with presentations by the NASA Headquarters Program Managers and Focus Area Leads listed below. The

contents of their remarks are provided in the presentations found at: *modis.gsfc.nasa.gov/sci_team/meetings/200601/plenary.php*.

Presenters included:

- **Don Anderson**: *Focus Area Lead, Climate Variability and Change*
- **Diane E. Wickland**: *Focus Area Lead, Carbon Cycle and Ecosystems*
- **Jared Entin**: *Focus Area Lead, Water and Energy Cycle*
- **Jeffrey Halverson** (for Ramesh Kakar): *Focus Area Lead, Weather*
- **Martha Maiden,** *Program Executive for Data Systems*: *EOSDIS Evolution in Support of Measurement Needs/Science*
- **Ronald J. Birk**, Program Director, NASA Applied Sciences Program: *Decision Support through Earth Science Research Results*

The morning plenary session was followed by a two-hour Poster Session. Some of the posters provided are at: *modis.gsfc.nasa.gov/sci_team/meetings/200601/poster.php.*

Following the Poster Session, the afternoon plenary session convened.

Steve Running [University of Montana] provided a review of MODIS land sciences and applications progress. An impressive volume and array of MODIS science is being published. MODIS albedo products are being produced in several resolutions and are being used in a weather forecasting model and to analyze fire-induced albedo change and its radiative forcing in northern Australia. Burn scar data are being used to analyze wildfire disturbances for burned-area recovery. The Enhanced Vegetation Index (EVI) and Land Surface Temperature (LST) products are being used together to track disturbances in vegetation. Global maps of phenology, temperature-driven phenology in North America, and precipitation-driven phenology in Africa using Tropical Rainfall Measuring Mission (TRMM) precipitation observations are among the results now appearing. MODIS EVI along with Leaf Area Index (LAI) products are being used to monitor vegetation seasonality in the Amazon. A vegetation index anomaly is being used to monitor drought. Other products in development include an evapotranspiration product and an integrated MODIS-SeaWinds phenology. All these efforts are leading to global as well as regional estimates of Net Primary Productivity, and Gross Primary Productivity. When MODIS is combined with AVHRR, the record of these variables spans many years. Overall, the use of MODIS in land science is very impressive and extends worldwide.

Chris Justice [University of Maryland, College Park (UMCP)] provided a review of MODIS land applications. For most land applications, data from multiple sensors are needed. For example, daily moderate-resolution products are useful for change detection while high-spatial-resolution data are needed for quantifying change. If the goal is to transition applications from research to operational decision-support systems, there must be a continuity of data products. The Global Agricultural Monitoring (GLAM) Project with the U.S. Department of Agriculture Foreign Agricultural Service uses MODIS real-time and time-series data to monitor crop conditions around the world. The uptake of MODIS fire data has been extensive. For example, a fire early-warning system is being developed for South Africa and conservation lands, and the U.S. Department of Agriculture's (USDA) Forest Service has implemented a rapid-response system into their decision-making system. The MODIS burned-area product will be available in *Collection 5*. The number of direct MODIS broadcast sites is growing and there is a demand for higher-order products from direct broadcast, for example, for real-time detection of vegetation change from deforestation. Work is also going forward to combine data from MODIS and the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER).

Robert Arnone [Naval Research Laboratory] talked about how MODIS ocean products are being used to understand coastal ocean processes. Advanced ocean-color algorithms can detect different components of coastal waters in addition to chlorophyll. MODIS near-surface observations and sea-surface-temperature data are improving physical circulation models. MODIS bio-optical observations combined with biological models provide a new method to determine the processes influencing coastal fluxes. MODIS ocean data can also be used for particle tracking of ocean features to predict and forecast ocean processes.

William "Barney" Balch [Bigelow Laboratory for Ocean Sciences] spoke about ocean carbonate dynamics. When most people think of carbon cycle science and the ocean, they think of particulate organic carbon, but particulate inorganic carbon, or calcium carbonate, is one of the major carbon pools on Earth. Ocean calcite is an important part of the global carbon cycle because it makes the biological pump run faster. It is an important source of light scattering, can be quantified from space, and is becoming a major environmental issue as the oceans are being acidified with anthropogenic carbon dioxide. MODIS measurements will be instrumental for constructing global-ocean-carbon budgets.

Christina Hsu [NASA GSFC] talked about the synergy of MODIS *Deep Blue* and operational aerosol products with the Multi-angle Imaging SpectroRadiometer (MISR) and the Sea-viewing Wide Field-of-view Sensor (SeaWiFS). Accurate aerosol measurements are needed to understand the role of aerosol forcing in climate change. MODIS *Deep Blue* makes it possible to measure aerosol optical depth over bright surfaces where no such measurement was possible before. *Deep Blue* can identify the source of dust storms over bright regions like the Sahara and the Middle East and can distinguish between dust and anthropogenic fine-mode aerosols. *Deep Blue* can also be used with SeaWiFS and MISR data.

Steve Ackerman [University of Wisconsin] spoke about the comparison of MODIS radiances and atmosphere products with Atmospheric Infrared Sounder (AIRS), MISR, and ground-based measurements. Combining observations from different sensors improves confidence in radiance, provides insight to physical processes, and helps mitigate weaknesses of a particular instrument. Combined observations also improve products like cloud detection, cloud top pressure, water vapor, and volcanic ash cloud.

The **MODIS Calibration/Characterization Group** met in the evening. The presentations covered the following subjects (see: *modis.gsfc.nasa.gov/sci_team/meetings/200601/cal.php*):

- *An Overview of MODIS On-orbit Performance*—**Jack Xiong** [NASA GSFC—MODIS Characterization and Support Team Leader and MODIS Project Scientist, GSFC]
- *Analysis of MODIS-MISR Cross-Calibration*—**A. Lyapustin** [University of Maryland-Baltimore County]
- *MODIS LWIR CO_2 Band Radiometric Performance*—**C. Moeller** [University of Wisconsin]
- *MCST-MODLAND Activities*—**C. Vermote** [UMCP]
- *MODIS Aqua Point Spread Function (PSF)*—**G. Meister** [NASA GSFC—Ocean Data Processing Team, GSFC]

January 5

This day was spent with each of the Discipline Groups (Land, Ocean, and Atmospheres) having presentations and discussion of science and topics related to MODIS processing and other issues. The presentations made during those meetings are listed and can be accessed at: *modis.gsfc.nasa.gov/sci_team/meetings/200601/index.php*.

January 6

In the closing plenary session several summary presentations were made describing on-going activities and main points covered in discipline group meetings.

Robert E. Murphy [George Mason University—Senior Staff Scientist, Integrated Program Office (IPO)] provided an overview of the progress on the National Polar-Orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP) and the Visible Infrared Imager/Radiometer Suite (VIIRS). The NPOESS program has experienced delays and cost overruns, primarily due to problems with the VIIRS sensor. This has triggered extensive internal and external reviews including an Independent Program Assessment (IPA), which identified a number of technical and programmatic issues. The assessment committee recommended increased testing to ensure the technical integrity of the instrument. The NPP mission has moved to an afternoon orbit resembling Aqua and Aura, and will be launched in 2008 or later.

Michael King [NASA GSFC—MODIS Atmospheres Discipline Group Leader] reported on the Atmosphere Discipline Group meeting held on January 5, 2006. *Collection 5* production is moving forward, with enhancements in the cloud mask, cloud product, aerosol product, and water vapor product. *Collection 5* will be available through the Goddard DAAC and the Atmosphere Archive and Distribution System (AADS). The *Deep Blue* algorithm has been developed to retrieve aerosols over bright surfaces. Spatially complete Spectral Albedo Maps were developed in collaboration between the land and atmosphere teams and are being used by various modeling groups. Work is going forward to compare Medium Resolution Imaging Spectrometer (MERIS) on the European Space Agency's ENVISAT Mission, and MODIS surface albedo data. MODIS polar-wind measurements are having a large impact on medium-range weather forecasting.

Chris Justice [UMCP—MODIS Land Group Leader] reported on the Land-Discipline Group meeting held on January 5, 2006. Testing is underway for *Collection 5*, and production will start at the end of March. The DAAC product review at the National Snow and Ice Data Center began on January 14. The United States Geological Survey (USGS) is determining the requirements for a MODIS archive. An international workshop will be held in August to discuss long-term global monitoring of vegetation and land-validation issues. The MODIS Land Team will be writing *white papers* on NASA land-science data needs across the science focus areas. The VIIRS land processing system (PEATE) is under development, and will need to generate additional products from the VIIRS instrument to meet NASA land-science needs. The land community needs global high-resolution data. The Landsat 7 scan-line corrector failure is a serious issue to the land-science community. It has resulted in a serious data gap, which may be filled as a multi-source dataset is developed. The date of the launch of the Landsat Data Continuity Mission will determine the length of the data gap.

Chuck McClain [NASA GSFC—MODIS Oceans Group Leader] reported on the ocean discipline group meeting held on January 5, 2006. MODIS/Aqua and SeaWiFS reprocessing has been done to make the two more consistent. Sea-surface temperature processing has moved to the Ocean Biology Processing Group to support the Global Ocean Data Assimilation Experiment (GODAE) high-resolution sea-surface-temperature pilot project. The Ocean Team is working on high-resolution coastal data processing using the high-resolution MODIS bands. The SeaWiFS Bio-optical Archive and Storage System (SeaBASS) archive for datasets continues to develop. Evaluation products for fluorescence line height and calcite are available and the Photosynthetically Active Radiation (PAR) product is ready for implementation. The ocean-color web page contains all information about products, data access, and so forth with good documentation. The Marine Optical Buoy (MOBY) has provided a constant dataset, but is being redesigned because the current system will be pulled in 2007. The ocean group has also been very active in monitoring the development of VIIRS because it is the next sensor for oceans.

Jack Kaye [NASA Headquarters—Director, Research and Analysis Program, Earth-Sun System Division] provided an overview of NASA Earth science. NASA was restructured in 2004 with a single Science Directorate, which is now divided into four divisions: Earth, Sun, Space, and Solar System. NASA Earth science is involved in a number of interagency activities such as the climate and oceans initiatives. The National Research Council (NRC) *Decadal Survey for Earth Science Observations* is underway with a final report scheduled for release this fall. The HYDROS mission will not move forward, and the Upper Atmosphere Research Satellite (UARS) and TOPEX/Poseidon have been decommissioned. Modeling and data assimilation progress is being made with the Columbia fast supercomputing program.

Paula Bontempi [NASA Headquarters—MODIS Program Scientist] talked about the future of the MODIS Science Team. The NASA Earth-science programs are changing from being oriented around mission-science teams to being oriented around measurement-science teams. With regard to measurement-science teams, the Oceans Team is up and running, the Land Team is in development, and the Atmosphere Team is moving forward. The NRC *Decadal Survey* is expected to drive the future of NASA Earth science. More interdisciplinary algorithm-development approaches are needed and will be stressed in future program development. Algorithm Theoretical Basis Documents (ATBDs) need to be peer-reviewed to assess and assure the quality of data-product suites.

Vince Salomonson [NASA GSFC—MODIS Science Team Leader] provided wrap-up comments. He noted that there exists one technical issue that may arise accompanied by potential impact on the availability of MODIS data due to loss of supersets in the Terra Solid State Recorder (SSR). If more supersets are lost, there will be a random loss of MODIS data. This problem can be resolved by doing a recycling process that is considered to be relatively low risk and has been done before. However, given the value of the Terra on-orbit assets and the importance of the mission to the NASA Earth science program, review and approval for this action has to come from NASA Headquarters. The alternative to recycling of the SSR supersets is to change the acquisition of MODIS data from 50% day/50% night to 60% day/40% night/day. This would seem to negatively affect products obtained over polar regions. Salomonson wants to accumulate rationale for recycling, so that we possibly can get the review and approval of NASA Headquarters before the problem occurs, thus reducing the time between approval and implementation of appropriate actions. Please send Salomonson any data or comments regarding any impacts or lack thereof regarding going to a 60/40 condition versus a 50/50 condition as outlined above.

Consideration is going to be given to having the next meeting sometime between June and October outside of the Washington/Baltimore area. We will be looking for ideas, guidance, etc., to see what place and kind of meeting would be best.

Salomonson reiterated his appreciation to everyone for their participation and the efforts put forth in preparation of presentations and posters. He emphasized how impressed he is with the progress being made in the use of MODIS for science and applications including efforts wherein MODIS data are fused with data from other sensors and/or assimilated into models. It is expected that such efforts will be well received as the NASA Earth science programs continue to move the focus from missions to measurements in the upcoming months. Team members can expect that the next Science Team meeting will necessarily examine progress and plans in this regard. ■

International EOS/NPP Direct Readout Meeting 2005

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Bob Kannenberg, rkannenb@pop900.gsfc.nasa.gov, Direct Readout Laboratory, GSFC

Introduction

The International EOS/NPOESS Preparatory Project (NPP) Direct Readout Meeting 2005 was hosted by the Mediterranean Agency for Remote Sensing and Environmental Control (MARSec) in Benevento, Italy, October 3-6. This year's meeting attracted participants from the government, vendor and academic communities, representing 19 different countries. **Patrick Coronado** [NASA Goddard Space Flight Center (GSFC)] chaired the meeting, organized by **Liam Gumley** [University of Wisconsin (UW)], **Maurizio di Bisceglie** (University of Sannio), **Paolo Antonelli** (MARSec), **John Overton** [National Polar-orbiting Operational Environmental Satellite System (NPOESS) Integrated Program Office (IPO)], and **Darrell Robertson** [NOAA National Environmental Satellite, Data and Information Service (NESDIS) Direct Services Division.] Since the last international meeting in 2003, the Direct Readout community has made great strides in obtaining, developing, and utilizing science algorithms for real-time and temporal applications. At this year's meeting, participants presented and discussed the latest application algorithms and systems and their impact on science, commerce, and decision-making infrastructures, and charted direction for the role of Direct Readout in the NPP and NPOESS eras. (A complete set of posters and presentations is available online at *dbmeeting.gsfc.nasa.gov/posters_presentations.cfm*.)

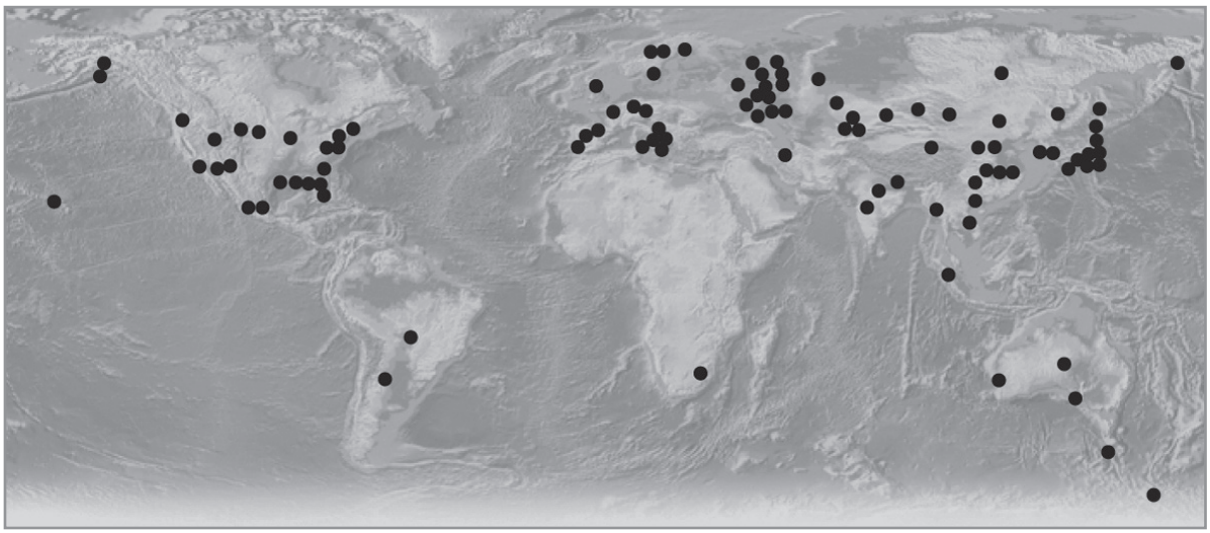
Setting the Stage

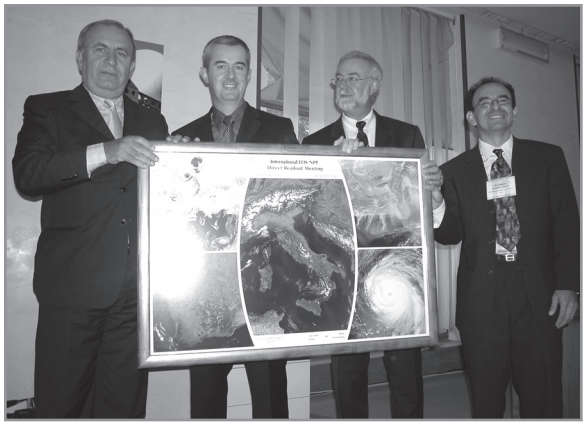
Direct Readout—the process of acquiring freely transmitted live satellite-data—originated in 1983, when NASA GSFC and NOAA joined forces to develop a complete satellite ground system based entirely on the use of Direct Broadcast data. (*Direct Broadcast* refers to the real-time transmission of satellite data to the ground and has been available since the late 1960s.) Users with compatible ground receiving equipment and in direct line of sight to a satellite may receive Direct Broadcast data, and there are now 100 verified X-band EOS Direct Broadcast sites worldwide. As Direct Readout technologies have become more affordable and accessible (especially with the emergence of the World Wide Web), tools have been developed by the remote-sensing community to make satellite data easier to acquire, process, and utilize. As a member of this community, NASA supplies many of these tools to foster global data exchange and scientific collaboration. Live, local, and regional environmental data, in turn, benefit environmental, commercial, and public-interest decision making.

Direct Readout Today: Awareness, Accessibility, and Impact

As awareness and accessibility of Direct Readout have increased, so has its impact. Presentations during the first three days of this year's meeting highlighted a multitude of new and innovative uses for Direct Readout data, such as synergistic processing, in which data from different sensors are combined to create new tools, e.g., new cloud-masking capabilities result from combining data from the Atmospheric Infrared Sounder (AIRS) and the Moderate Resolution Imaging Spectroradiometer (MODIS). Direct Readout data also continue to be valuable to a variety of environmental research topics, e.g., cloud research in Europe and climate research in Brazil. The real-time utility of Direct Readout makes it particularly useful, if not essential, for understanding and mitigating natural disasters. Firefighters in Montana use Direct Readout MODIS fire products to help allocate resources to fight wildfires. Direct Readout makes it possible for Polar wind data to be factored into

Map of MODIS Direct Broadcast sites worldwide.





Top: President of Benevento Carmine Nardone (L) with (L-R) Liam Gumley (UW), John Overton (NOAA IPO), and Patrick Coronado (NASA GSFC).

Bottom: Antenna tower at MARSec, designed by a local artist.

hurricane track forecasts in real time, improving accuracy by 50 nautical miles.

Direct Readout data are increasingly as accessible to the general public as they are to researchers, forecasters, and government agencies. Direct Readout data from stations all over the world are being shared and made available online with tools like Open-source Project for a Network Data Access Protocol (OPeNDAP), Open-source Abstract Data Distribution Environment (OpenADDE), and HTTP and FTP protocol-based Web clients. Web tools even allow users to create their own *virtual ground stations*, and receive global data from geographic locations of their choice. The vendor community continues to reduce the cost of X-band EOS/NPP ground systems, making affordable ground systems more easily available worldwide, especially to developing areas which benefit substantially from access to data. Tools to process raw data are available for free online. For example, the International MODIS/AIRS Processing Package (IMAPP), developed by UW, allows users to calibrate, geolocate, and create environmental products from raw data, and the Sea-viewing Wide Field of View Sensor (SeaWIFS) Data Analysis System (SeaDAS), developed by the Ocean group at GSFC, provides users with a comprehensive image-analysis package for the processing, display, analysis and quality control of ocean-color data. Many more software tools are becoming available, and NASA will make an initial attempt at consolidating this list by the next meeting.

Direct Readout Tomorrow: NPP and NPOESS

The fourth day of the meeting was largely devoted to presentations on upcoming continuity missions. Government agencies and corresponding contractors detailed the planned transitions from EOS to NPP and, ultimately, NPOESS. Highlights included presentations on science objectives, the transition from MODIS to the Visible Infrared Imager/Radiometer Suite (VIIRS), and insights into the Cross-track Infrared Sounder (CrIS) and Advanced Technology Microwave Sounder (ATMS). Also presented were plans for Sensor Data Records (SDRs) and algorithm wrapper developments at GSFC's Direct Readout Laboratory (DRL). IPO presented its NPOESS calibration and validation plans, and solicited input from participants as to how the Direct Readout community can contribute to these efforts. A new processing environment, called the International Polar Orbiter Processing Package (IPOPP) is being developed jointly between the IPO, UW, and NASA GSFC to support interdisciplinary processing for NPP and NPOESS data.

Topics for Further Discussion

While justifiably proud of their achievements to date, meeting participants challenged themselves to further expand the reach and utility of Direct Readout. How can large datasets be moved as efficiently as possible, in order to make meaningful data more accessible to experienced and inexperienced users alike? What kind of standards might be developed or adopted to assist in this effort? There are currently 100 verified X-band Direct Broadcast sites worldwide, but very few of these are located in remote areas that would benefit greatly from the data, e.g., Africa and South America. How can the Direct Readout community better serve remote, often impoverished areas, given the relatively high cost of bandwidth? And as important, how can they help make available the resources and expertise to develop region-specific applications which could serve these areas of the world? The Direct Readout community looks forward to meeting these challenges and more prior to its next international meeting. For more information, go to *directreadout.gsfc.nasa.gov* ■

ESIP Federation Winter Conference

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The Federation of Earth Science Information Partners (ESIP Federation) recently held its winter conference in Washington, D.C. Each winter, the ESIP Federation convenes its technical meeting, with this year's theme being, *The Earth Information Exchange: Delivering Data to Decision Makers*. The conference primarily focused on issues related to developing, building, and maintaining the ESIP Federation's portal, The Earth Information Exchange (EIE). The EIE provided an opportunity to the meeting's attendees to also focus on one cross-cutting and six policy issues to be housed within the EIE. The policy issues are: Air Quality Management, Coastal Management, Disaster Management, Public Health, Water Management, and Education; and the cross-cutting issue is Education.

The meeting's technical tracks—Data Quality and Stewardship, Metadata Services, and Web Services Chaining—met in a series of breakout sessions throughout the meeting. Speakers from both inside and outside the ESIP Federation spoke. A summary of each technical track is provided below:

Data Quality and Stewardship Track

The technical track session on Data Quality and Stewardship was divided into three sessions: 1) Models for stewardship and archival including discussion of a maturity model, climate-data record (CDR) production models, and societal-application business models; 2) Presentations in thematic areas of reanalysis, production of Earth radiation CDRs, long-term surface-temperature and precipitation CDRs, and marine-ecosystem needs for CDRs; and 3) Working group sessions to distill the above sessions with a focus on *what to archive* and action items. The sessions were well attended and resulted in a set of conclusions and an action item, to be taken up at the next ESIP Federation meeting.

Metadata Services Track

The Metadata Services technical track focused on several issues relevant to the ESIP Federation's EIE portal and future data systems. The EIE will point to existing portals, rather than duplicate their services and metadata records. Richer metadata descriptions will be used to enable semantic integration and machine-to-machine communications. Third-party metadata are to be encouraged to meet the needs of specialized communities, e.g., education. The EIE will implement conventions to identify duplicate metadata records when multiple sites or clearinghouses are harvested. More International Organization for Standardization (ISO) standards for datasets will be sought.

Web Services Chaining

The goals of the Web Services Chaining track were to:

1. foster inter-disciplinary collaborations;
2. accumulate a catalog of available services in the ESIP Federation, with links to the service interfaces (Web Service Description Language or WSDL documents); and
3. construct value-added service chains in which Simple Object Access Protocol (SOAP), Open-source Project for a Network Data Access Protocol (OpenDAP), or Open Geospatial Consortium Web Map Service/Web Coverage Service (OGC WMS/WCS) services provided by ESIP Federation members (or others) are connected to form a composite workflow.

During the meeting, several live service chains were demonstrated that connected EOS ClearingHOuse (ECHO) data query services to OpenDAP or SOAP analysis services. Attendees also discussed the potential development of a Federation services taxonomy, standard interfaces for simple services such as space/time data queries, and interoperability between SOAP, OpenDAP, and OGC services. At the next Federation meeting, all the available Federation services will be entered into the ECHO services registry as a way of demonstrating multiple service chains using both the Business Process Execution Language (BPEL) Power and Scientific Dataflow (SciFlo) workflow engines.

Science and Applications Tracks

The policy tracks (a.k.a., science and applications) focused on community building within their respective areas. Each policy track examined the existing community within the ESIP Federation and studied what strengths, gaps, and opportunities faced them. Further, each of the policy tracks began to identify content for the EIE's communities that align with the respective policy areas. The policy-track efforts are organized as Clusters of interested Federation partners, with typically 12-15 partners in each Cluster. The Clusters are continuing their efforts to organize the applications and policy communities, with an emphasis on bring-

ing Earth-system modelers and environmental decision makers into the process, and on identifying critical national decision challenges to which they can make an immediate contribution. Federation president **Thomas Yunck** [Jet Propulsion Laboratory] noted that "*the ravages of hurricane Katrina and the imponderable consequences of climate change make it clear that we as a nation must dramatically improve our ability to mobilize the best available scientific information and bring it to bear on planning, policy, decision making, and disaster response on time scales from minutes to decades. With its nearly 100 partners representing every domain of environmental information collection, reduction, and dissemination, the ESIP Federation is uniquely positioned to make a decisive contribution to this critical national need.*" The policy tracks will meet again during the ESIP Federation's Summer Conference, July 19-21, 2006.

Supporting both the technical and policy tracks was a series of plenary and meal-time speakers. Speakers included: **Jack Kaye** [Director of NASA's Earth-Sun System Research and Analysis Program]; **Conrad Lautenbacher** [NOAA Administrator]; **Ron Birk** [Director of NASA's Earth-Sun System Applied Sciences Program]; **Thomas Yunck** [ESIP Federation]; **Doug Nebert** [Federal Geographic Data Committee (FGDC)]; **Chuck Meertens** [UNAVCO and Geosciences Network (GEON)]; **Myra Bambacus** [NASA's Geospatial Interoperability Office]; **Kathy Fontaine** [NASA's Data Systems Working Group and US GEO]; **Paul Hearn** [USGS—Societal Impacts Office] and **John Caron** [Unidata].

For more information about the ESIP Federation, contact Carol Meyer at 877-870-3747 or *carol.meyer@earthsciencefoundation.org*. ■

Kudos

EOS Senior Project Scientist, **Michael D. King**, was recently elected a Fellow of the American Geophysical Union (AGU). King is being recognized for his "enduring seminal theoretical and experimental methods for the remote sensing of the optical properties of aerosols and clouds, and understanding their roles in weather and climate," and for his leadership of NASA's Earth Observing System.

AGU recognizes members and others who have made outstanding contributions to the advancement of the geophysical sciences, to the service of the community, and to the public's understanding. The title of Fellow is conferred upon not more than 0.1% of all AGU members in any given year. King will be among those honored at the AGU Joint Assembly in Baltimore, MD, May 23-26, 2006.

The Earth Observer staff and the entire scientific community congratulate King on this outstanding achievement.

NASA Finds Stronger Storms Change Heat and Rainfall Worldwide

Rob Gutro, rgutro@pop900.gsfc.nasa.gov, Goddard Space Flight Center

Studies have shown that over the last 40 years, a warming climate has been accompanied by fewer rain- and snow-producing storms in mid-latitudes around the world, but the storms that are happening are a little stronger with more precipitation. A new analysis of global satellite data suggests that these storm changes are affecting strongly the Earth's water cycle and air temperatures, and creating contrasting cooling and warming effects in the atmosphere.

The mid-latitudes extend from the subtropics (approximately 30° N and S) to the Arctic Circle (66° 30" N) and the Antarctic Circle (66° 30" S) and include pieces of all of the continents with the exception of Antarctica.

George Tselioudis and **William B. Rossow**, both scientists at NASA's Goddard Institute for Space Studies (GISS) and Columbia University, New York, authored the study that appears in the January issue of the American Geophysical Union's journal, *Geophysical Research Letters.*

"There are consequences of having fewer but stronger storms in the middle latitudes both on the radiation and on the precipitation fields," Tselioudis said. Using observations from the International Satellite Cloud Climatology Project (ISCCP) and the Global Precipitation Climatology Project (GPCP), Tselioudis and Rossow determined how the changes in intensity and frequency of storms are both cooling and warming the atmosphere around the world.

Fewer and stronger storms in the mid-latitudes affect the radiation field, that is, the solar energy being absorbed and the heat radiation emitted by the Earth. There are two things happening with storms and energy. The first is that sunlight is reflected back into space from the tops of the clouds, creating a cooling effect at the Earth's surface. Conversely, clouds also act to trap heat radiation and prevent it from escaping into space, creating a warming on the Earth's atmosphere.

A 1998 study of precipitation data for the continental U.S., showed an increase in more extreme rainfall and snowfall events over the previous 70 to 90 years. Further, climate model studies that Tselioudis and others performed in the last few years indicate that additional levels of carbon dioxide will lead to fewer but more potent storms as has been the case in the last 50 years.

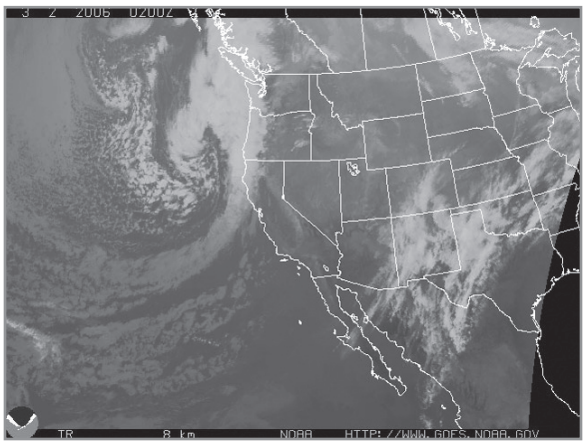
In the present study, whenever a leading climate model predicted a change in the number of storms and/or their intensity, the radiation effects of stronger storms were found to be greater than those produced by the related decrease in the number of storms. Fewer storms mean less cloud cover to reflect sunlight and that adds heat to the Earth. However, more intense storms tend to produce thicker clouds which cool the atmosphere. Tselioudis and Rossow looked at both of those factors, and calculated that the cooling effect is larger than the warming in all months except June, July and August, when the two effects cancel each other.

In terms of precipitation from these storms, the effects of increasing storm intensity also surpass those of decreasing storm frequency. In the northern mid-latitudes, the stronger storms produce 0.05–0.08 millimeter (mm)/day (.002-.003 inch/day) more precipitation. Although this number seems small, the average precipitation daily in the northern mid-latitudes is only around 2 mm/day (.08 inch/day), implying that the strengthening of the storms produces a 3-4% precipitation increase that comes in the form of more intense rain and snow events.

The long-term changes in sunlight and heat produced by the storms have been hard to observe because scientists only have observations for the last 25 years. Also, there are other things that affect how much sunlight is being reflected and absorbed by the Earth, and those are constantly changing. For example, when black soot falls on snow, the black soot absorbs heat from the sun, whereas the white ice would have reflected most of it.

This study presents a method that uses current climate relationships and climate change model predictions to arrive at more complete estimates of radiation and precipitation changes that may occur in a warmer climate. ■

Comma-shaped storm systems in the mid-latitude regions, like the one shown here on the Pacific Northwest coast, produce our everyday weather but also determine the radiation, heat, and water budgets of those regions. This image was taken from the Geostationary Operational Environmental Satellite, March 2, 2006. Credit: NOAA



NASA Scientists Study Pollution's Origins and Air Quality Impact

Rob Gutro, rgutro@pop900.gsfc.nasa.gov, Goddard Space Flight Center

In Mexico City, a team of researchers from NASA and other institutions have kicked off the first phase of one of the most complex field campaigns ever undertaken in atmospheric chemistry. Researchers will use data from research satellites, aircraft and ground-based instruments to investigate the transformation of air pollution as it flows downwind from Mexico City and learn more about impacts of air pollution on human health and climate.

From March 1 through May 15, NASA and its partners will carry out the Intercontinental Chemical Transport Experiment (INTEX-B). The experiment is the second of a broader two-phase NASA project to study the transport and evolution of gases and tiny particles, called aerosols, across continents and to assess their impact on regional air quality and climate. During INTEX-B, researchers will pursue the origins of pollution that ultimately finds its way to North America and affects air in the troposphere, the lower part of the atmosphere where we live and breathe.

As part of INTEX-B, NASA participated in a field study through March 29 called Megacity Impacts of Regional and Global Environments (MIRAGE), led by the National Center for Atmospheric Research (NCAR), Boulder, CO. The results are expected to be applicable to the world's megacities, those with 10 million or more inhabitants. Other participants include the National Oceanic and Atmospheric Administration, the U.S. Department of Energy, several U.S. universities, and more than a dozen Mexican partners.

"There has been significant growth in the size and number of megacities like Mexico City, the second largest in the world with 18 million residents," said atmospheric chemist **Hanwant Singh**, lead mission scientist for INTEX-B at NASA's Ames Research Center, Moffett Field, CA. "These cities generate atmospheric concentrations of pollutants that routinely exceed international standards. We must determine how this pollution from other regions affects our air quality. Ultimately, this is very much tied to human health."

Both high-flying aircraft such as the NASA DC-8 and DLR Falcon-20 aircraft and low-flying aircraft like the National Science Foundation (NSF)/National Center for Atmospheric Research's (NCAR) C-130 and the U.S. Department Of Energy's (DOE) G-1, will be used to provide comprehensive radiation, chemical, physical, and visual measurements of gases and aerosols. INTEX-B researchers will also closely coordinate their observations from planes with that of NASA satellites, especially Aura, Aqua, and Terra, as well as the European Envisat.

"There is tremendous value in linking data from the 40 instruments aboard the DC-8 aircraft to that captured by our research satellites to get a comprehensive picture of the composition of the air transported to and from the U.S.," said **Bruce Doddridge**, director of the Tropospheric Chemistry Program at NASA Headquarters, Washington, DC. "With the experience gained in comparing the aircraft and satellite measurements made during this campaign, we can more confidently apply our satellite measurements to studying air quality all over the world."

"The world is urbanizing," said NCAR scientist **Sasha Madronich**, one of the principal investigators for MIRAGE. "If we can understand the pollution impacts of Mexico City, we can apply this new knowledge to other urban areas across the globe."

Last year's first phase of INTEX explored the makeup and transport of air from the U.S. to Europe. The second part of NASA's INTEX-B project will be completed in April when Asian pollution transport to North America is at its peak. The INTEX-B and MIRAGE field studies are components of a set of simultaneous field campaigns collectively called Megacity Initiative: Local and Global Research Observations (MILAGRO).

For more detail on NASA's involvement in INTEX-B on the Web, visit: *www.nasa.gov/centers/goddard/news/topstory/2006/gas_transport.html*

Mapping Surface Water for Flood Control

Rosemary Sullivant, rsulliva@jpl.nasa.gov, NASA Jet Propulsion Laboratory

Too much rain can be as big a problem as too little. A NASA instrument designed primarily to measure winds on the ocean surface is turning out to have other abilities over land that may help in both flood and drought situations.

Large hurricanes, such as *Katrina* and *Rita*, carry massive amounts of moisture deep inland, well beyond the coast where they come ashore. Weather radar shows rain in the atmosphere but not where it has fallen on the surface. While rain gauges measure how much rain has fallen in specific locations, their coverage is limited.

Working with data from the SeaWinds instrument on the QuikSCAT satellite, researchers have found a new way to make an immediate measurement of the amount of precipitation that has accumulated on the surface and its location. These are important factors in evaluating the flood potential of a particular region, especially when new storms hit areas already coping with large amounts of water from previous storms.

SeaWinds on QuikSCAT is a *scatterometer*—it sends out a pulse of radar that scatters back to the satellite from Earth's surface. Over the ocean, this backscatter reveals the speed and direction of ocean surface winds. SeaWinds data have become an important factor in improving hurricane forecasting. The satellite also collects data over land, and researchers have discovered that they can use radar backscatter from land to determine increases in surface soil moisture resulting from rainfall. By comparing the radar backscatter from before and after Hurricane Katrina made landfall, researchers were able to map rainwater distribution from the category-5 storm from the coastline to the Great Lakes. They also mapped the increase in surface water caused by Hurricane Rita (see images *photojournal.jpl.nasa.gov/catalog/PIA03029*).

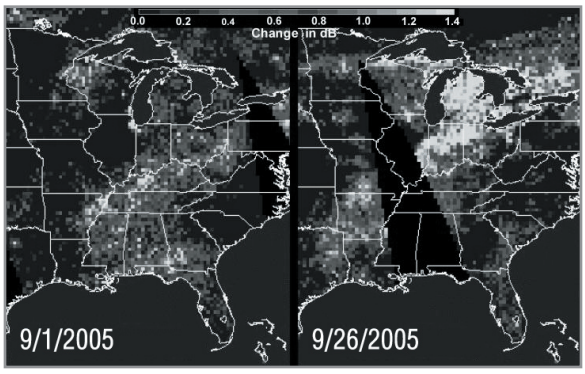
"This is an innovative application for the QuikSCAT satellite," says **Son Nghiem**, a JPL specialist in remote sensing. "Many states are impacted from a large category-5 hurricane. For such a large area, it takes months to assemble final and consistently quality-controlled data from rain gauges. Now we can get information of rainwater on land from a single instrument. We can monitor the rainwater distribution on a continental scale."

"The capability of SeaWinds to monitor both the winds that move the moisture from the ocean and the water deposited over land makes the scatterometer a critical instrument in the characterization and understanding of the cause and effect of hurricane landfalls," says **Timothy Liu**, the QuikSCAT Project Scientist at JPL.

"Now that we've shown that SeaWinds is sensitive to surface water," says Nghiem, "we are going to be using it to monitor surface water from storms as well as in a new program for drought detection and monitoring." Nghiem is the principal investigator of a recently selected NASA proposal to help develop a national drought-monitoring system for drought early warning using data from NASA satellites. Collaborating in the program are the University of Nebraska-Lincoln's National Drought Mitigation Center, the National Oceanic and Atmospheric Administration, the U.S. Geological Survey, and Dartmouth College.

"We hope to improve our ability to monitor and forecast drought, information that is crucial for decision makers in such areas as hazard management and mitigation, water management, agriculture, hydropower, and forestry," says Nghiem. ■

The images below, derived from NASA QuikSCAT satellite data, show the extensive pattern of rain water deposited by Hurricanes Katrina (left image) and Rita (right image) on land surfaces over several states in the southern and eastern United States. These results demonstrate the capability of satellite scatterometers to monitor changes in surface water on land.



TOPEX/Poseidon Sails Off Into the Sunset

Rosemary Sullivant, rsulliva@jpl.nasa.gov, NASA Jet Propulsion Laboratory

After a remarkable 13-year voyage of discovery, TOPEX/Poseidon, the first great oceanographic research vessel to sail into space, ended its mission recently, after having lost its ability to maneuver late last year.

Launched in 1992 to make precise measurements of the ocean surface, TOPEX/Poseidon was watching in 1997 when the largest El Niño in 100 years changed weather patterns around the world. "TOPEX/Poseidon didn't discover El Niño," says mission scientist **Lee-Lueng Fu**, a JPL oceanographer, "but it did give us our first global perspective on this and other short-term climate events such as La Niña. It allowed us to follow their evolution and showed that these events weren't limited just to the tropics. It also gave us evidence of even longer-lasting phenomena."

The mission's most important achievement was to determine the patterns of ocean circulation—how heat stored in the ocean moves from one place to another. Since the ocean holds most of the Earth's heat from the Sun, ocean circulation is a driving force of climate. "TOPEX/Poseidon has given us the longest and most complete observations of surface circulation in the deep ocean," says Fu. TOPEX/Poseidon made it possible for the first time to compare computer models of ocean circulation with actual global observations and use the data to improve climate predictions.

Another of the mission's major accomplishments was to map global tides for the first time. "Tides are the most visible changes in the ocean on a daily basis," explains Fu. "They are important for navigation, they have a big role in biological activity, and they are the major source of mixing in the ocean. The mixing may be small in scale, but it has a huge effect." Before TOPEX/Poseidon, tides in the open ocean could only be estimated.

TOPEX/Poseidon was the first mission to demonstrate that the Global Positioning System could be used to determine a spacecraft's exact location and track it in orbit. Knowing the satellite's precise position, to within 2 cm (less than 1 in) in altitude, was a key component in making accurate ocean-height measurements possible.

"TOPEX/Poseidon revolutionized oceanography by giving us the first global-ocean observing system," says Massachusetts Institute of Technology oceanographer **Carl Wunsch**, one the mission's architects and early champions. Oceanographer **Walter Munk**, Scripps Institution of Oceanography, described the joint U.S. and French mission as "the most successful ocean experiment of all times."

TOPEX/Poseidon

The ocean is a different place now than it was when TOPEX/Poseidon first set sail. The sea is warmer than it was and getting warmer faster. Global sea level is rising. Heat in the tropics is moving northward more slowly. In some regions, some currents are faster while others are slower than in the past.

"The biggest lesson from TOPEX/Poseidon is that the ocean is changing all the time," says Fu, "and it is changing rapidly."

Jason, launched in 2001, now continues the same observations begun by TOPEX/Poseidon. For the past three years, the two satellites have flown in tandem, providing twice the coverage of the sea surface and allowing scientists to study smaller features than could be seen by one satellite. A future mission, the Ocean Surface Topography Mission (OSTM), is planned for 2008. After that, scientists propose to make more-detailed measurements of ocean_surface topography to study critical issues such as sea-level rise. ■

NASA Helps Weed Our National Garden

Rob Gutro, rgutro@pop900.gsfc.nasa.gov, NASA Goddard Space Flight Center
Steve Cole, scole@pop600.gsfc.nasa.gov, NASA Goddard Space Flight Center

When people think of NASA, they usually think of space exploration. But NASA also explores our home planet, and the results of that exploration help other agencies provide substantial benefits to our society and economy. An example of NASA's Earth research leading to new benefits is in the area of the control of non-native plants such as the plants that may be reducing water supplies in the western United States.

NASA makes its Earth observations, modeling, and computational capabilities available to enhance the tools other agencies use to control invasive plant species. An *invasive species* is non-native (alien) to the ecosystem in which it's found. Often, invasive species cause economic or environmental harm or harm to human health. Invasive species can be plants, animals, and other organisms, e.g., microbes. Human actions are the primary means of invasive species introductions.

Invasive plant species traditionally are located, identified, and monitored by manual ground surveys. Such surveys are effective, but are expensive, time-consuming, and difficult to manage over large areas. Now, a new tool developed by the U.S. Geological Survey (USGS) is taking advantage of observations from NASA satellites and NASA systems engineering to provide a service for land managers that predicts quickly and inexpensively the location and spread of invasive plants over regional areas. The tool, called the Invasive Species Forecasting System (ISFS) was recently used to make the first predictive map of tamarisk habitat in the United States—see NASA lithograph Science Serving Society: Invasive Species (LG-2006-1-100-GSFC) available on-line at *eospso.gsfc.nasa.gov/eos_homepage/for_educators/educational_publications.php*

Top Image: Experts estimate that one large tamarisk plant has the potential to absorb up to 200 gallons of water per day—that's twice the amount the average person uses in the same timeframe.

Bottom Image: Researchers use satellites to measure sunlight reflected off plants and the environments in which they are growing. The changing colors of the Tamarisk, or saltcedar, plant aided researchers in creating the National Tamarisk Map.

Tamarisk is a large shrub to small tree native to Africa and Eurasia. It was introduced in the western U.S. in the early 1800s as *ornamental vegetation* and for wind and erosion control. Tamarisk has since spread and can be found from Minnesota to California and from Mexico to Canada. The U.S. Department of Agriculture recently identified tamarisk as one of the most harmful invasive species in the nation, because the plant's long roots tap into underground aquifers. Its groundwater-absorbing qualities may be adding to the severity of the drought in the western U.S. Tamarisk also increases the salt concentration of the soil and degrades habitats for native species along river systems.

"The ISFS combines NASA satellite data with tens of thousands of field-sampling measurements, which are then used to analyze past and present distributions of non-native plants and predict their future growth patterns," said **Tom Stohlgren**, director of the USGS National Institute of Invasive Species Science (NIISS). Land managers and others can use the ISFS to generate color-coded maps to help predict and manage the spread of troublesome invasive species.

The ISFS uses observations and data products from NASA's Terra, Aqua, and Earth Observing-1 satellites, and the USGS-operated Landsat satellites, together with field data from government and non-government contributors. All of these satellites observe and measure sunlight reflected by plants and the environments in which they are growing. The satellites are able to "lock in" on unique aspects of the reflected light to determine tamarisk's current locations as well as habitats that are vulnerable to invasion.

During the blooming season for tamarisk, ISFS-generated maps predicting tamarisk locations matched obser-

Researchers now estimate that tamarisk has infested more than 3.3 million acres in the western United States. With the invasion spreading like wildfire, this invasive species poses a serious threat to the West's water supply.

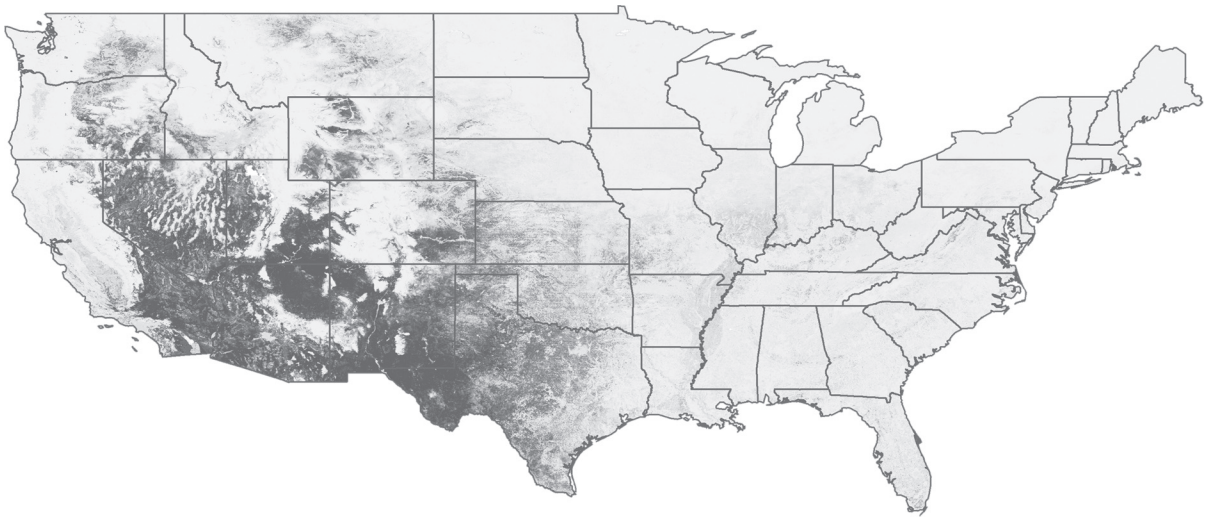
vations of the plant in the field. These predictive maps are an important new tool for land managers involved with tamarisk-related control and restoration efforts. "Satellite data coupled with computer modeling helps us understand where tamarisk is likely to be growing, even in remote locations that field researchers cannot easily reach," said **John Schnase**, principal investigator of the ISFS project at NASA's Goddard Space Flight Center in Greenbelt, Md.

The ISFS uses invasive-species occurrence and abundance data from the Global Organism Detection and Monitoring System developed by the USGS Fort Collins Science Center and Colorado State University. This monitoring system is an on-line database that allows people to report sightings of tamarisk or other invasive species to USGS scientists, who then review the observations and incorporate validated new data into ISFS map products.

Currently, USGS is using the ISFS to predict the distribution of other invasive species such as cheatgrass, Canadian star thistle, and certain aquatic species. "With this new technology USGS is significantly enhancing its ability to support invasive-species management. The enhancements in the ISFS are the result of the use of NASA observations, model output, and systems engineering," said **Ed Sheffner**, the Program Manager for Invasive Species in the Applied Sciences Program at NASA Headquarters in Washington.

NASA and USGS (through the Department of the Interior) are members of the National Invasive Species Council. It is an interdepartmental council with 13 cabinet-level member organizations. Formed by Executive Order in 1999, the council facilitates coordination and provides leadership for federal agencies working on invasive-species issues. ■

The USGS, with assistance from NASA data products and system engineering, created an on-line forecasting tool called the Invasive Species Forecasting System (ISFS). NASA data products, such as EVI, are part of the input to the ISFS. The ISFS produces predictive maps that show the relative suitability to sustain a particular invasive plant species. The map below shows habitat suitability for tamarisk, an invasive plant with major economic impact in the Western United States.



Scientists in Dogged Pursuit of Amount of Snow on Earth Embark on Arctic Trek

Gretchen Cook Anderson, cookander@comcast.net, NASA Goddard Space Flight Center

An expedition into the frozen Arctic using dogsled teams kicks off March 12 from Alaska to help NASA find out how much snow blankets the Earth. The trek is one leg of a multi-sponsor five-year *Go North!* expedition made up of multiple dogsled treks that will explore the Arctic in pursuit of environmental samples and observations.

Seven explorers, including scientists and teachers, will mush from Circle, Alaska, across the Arctic through May with two dog teams of 25 polar huskies with names like Ginger, Jupiter and Hershey, to collect samples of hydrometeorological snow data. The samples, to be gathered in five communities spread across the Alaskan Arctic, will be analyzed to help validate snow pack observations from NASA's Aqua satellite.

Snow pack refers to the snow that remains on the ground for weeks at a time. Researchers hope that analysis of the snow samples will also improve our understanding of how snow *metamorphoses*, or changes, after it lands on Earth. Snow crystals scatter microwave radiation that emanates from the ground. Researchers want to know better what type of crystals are more likely to be found in a particular region at a particular time of year. The more information they have about snow crystals from various areas of the snow-covered portion of the globe, the better they are positioned to more fully understand and interpret the satellite-derived data.

"In recent years snow cover has been declining in many areas of the globe," said physical scientist **James Foster** of NASA's Goddard Space Flight Center, Greenbelt, Md. "It has become ever more important to accurately measure the amount of snow in large watersheds, areas where melted snow drains into waterways. Public officials can then better determine how to manage limited water resources, especially in areas with the densest populations."

In the American West, snow is a particularly vital resource. According to Foster, about 70 percent of the water supply in western states comes from melting snow pack. Snow also drains from the Rockies and the Dakotas into rivers that feed the Mississippi and Missouri Rivers, America's primary sources of fresh water.

The ability to accurately measure snow packs has implications all over the globe. "Melting snow in the Himalayan region, for example, feeds rivers that supply water to over a half billion people. So it's key for us to better understand how much water is made available on a worldwide scale from melting snow packs," said Foster.

The Advanced Microwave Scanning Radiometer-EOS (AMSR-E) instrument aboard the Aqua satellite can measure snow in remote areas where ground and air surveys are difficult. Validation of the satellite measurements must be done, however, to ensure that the data from space are reliable. Validating snow measurements is especially difficult in regions where the terrain is not uniform, thereby posing a significant challenge for the AMSR-E sensors.

This is where the dogsled teams come in: they will be gathering data from extremely remote locations to help confirm the satellite observations. "The dogs are the super stars of the project. Without their abilities to get us from point A to point B we could not conduct this kind of critical work," said **Paul Pregont** of the University of Minnesota, Minneapolis, the trek's expedition leader. "Much of the route we are traveling does not allow motorized vehicles, so the only way to get there is by skiing or dog sledding."

At each data-collection point, researchers will dig a snow pit, confirm the location, air temperature, and snow depth. They will then collect snow crystals from the snow pit at different depths. The samples will be stored in liquid nitrogen and shipped to the U.S. Department of Agriculture (USDA)'s Henry A. Wallace Beltsville Agricultural Research Center where the crystals will be imaged with a low temperature scanning electron microscope to measure their size and denote their shape.

Polar huskies, a mixed breed of Northern native huskies, boast double coats of fur and strong legs. Dogsled team veterinarian Eric Jayne ensures that the dogs are in top condition and that each has a fully stocked medical kit of essentials. Each of the two dog teams consists of 12-13 huskies.

"The dogs have so much positive energy, that no matter how rough the weather, they are there in the morning to give you a lick and they are eager to get moving," said Pregont. "They really love being out in the cold air and out on the trek. They are born to live and work in these conditions."

The NASA-funded project is a collaborative effort with the University of Minnesota, USDA, the National Oceanic and Atmospheric Administration, the U.S. Geological Survey, the Meteorological Service of Canada, Quebec, and several other universities in the U.S., Canada and Europe. Over 3,000 classrooms around the world are learning along with *GoNorth!* through a K-12 distance learning program. ■

EOS Scientists in the News

Rob Gutro, rgutro@pop900.gsfc.nasa.gov, NASA Earth Science News Team
Stephen Cole, scole@pop600.gsfc.nasa.gov, NASA Earth Science News Team

Greenland Ice Loss Doubles in Past Decade, Raising Sea Level Faster, February 16; *Associated Press*, *ABC News World Tonight*, *Time*. Research led by **Eric Rignot** (NASA JPL) shows that the loss of ice from Greenland doubled between 1996 and 2005, as its glaciers flowed faster into the ocean in response to a warmer climate.

NASA Satellite Technology Helps Fight Invasive Plant Species, February 15; *Yahoo! News*, *KNXV-TV* (Phoenix), *WJZ-TV* (Baltimore), *KUSA-TV* (Denver). Products based on NASA Earth observations and a new Internet-based decision tool are providing information to help land and water managers combat tamarisk, an invasive plant species damaging water supplies in the western United States, say lead researchers **John Schnase** (NASA GSFC) and **Ed Sheffner** (NASA HQ).

NASA, University Scientists Uncover Lost Maya Ruins—From Space, February 15; *United Press International*, *Boston Globe*. Archaeologist **Tom Sever** (NASA MSFC), scientist **Dan Irwin** (NASA MSFC) and others used space- and aircraft-based remote-sensing technology to uncover remains of the ancient Maya culture in the rainforests of Central America.

New Yorkers' Workweek Clouds Air with Tiny Particles, Study Finds, February 13; *Space-India.net*, *Deoxy.org*. Using MODIS and AERONET data, researchers **Menglin Jin** (University of Maryland/NASA GSFC), **Michael King** (NASA GSFC) and **Marshall Shepherd** (formerly NASA GSFC) detected for the first time in an American city a *workweek pattern* of aerosols, believed to be generated by the comings and goings of people working in the city.

Archaeology Takes NASA Technology Underground, February 9; *New Orleans Times-Picayune*. **Marco Giardino** (NASA Stennis) used innovative NASA technology to discover important artifacts from excavations conducted on archaeological sites at Stennis Space Center.

La Niña Impact: California Fires, Dry Spell, February 8; *ABC World News Tonight*, *Washington Post*, *KTLA-TV* (Los Angeles). **Bill Patzert** (NASA JPL) discusses the return of La Niña and how it may be contributing to unseasonably warm weather and worsening ongoing wildfires in the Southwest.

NASA Post-Hurricane Katrina Images Available On Google Earth, February 3; *Science Daily*, *GISUser.com*, *Innovations Report* (Germany). By using NASA's Experimental Advanced Airborne Research LIDAR mapping system, scientists including **Charles Wright** (NASA Wallops), have produced detailed aerial imagery of the impact of Hurricane Katrina, now available on Google Earth.

Scientists Surf the Seas of Space to Catch an Atmospheric Wave, February 2; *Science Daily*, *SpaceRef.com*. Using satellite data from the Atmospheric Infrared Sounder (AIRS) instrument on NASA's Aqua spacecraft, a research team led by **Duane Waliser** (NASA JPL) discovered important new information on the water vapor, temperature profile, and vertical structure of the Madden-Julian Oscillation.

NASA Assesses Strategies to 'Turn Off the Heat' in New York City, January 31; *PhysOrg.com*, *Science Daily*. Researchers from a variety of private and public institutions, including **Stuart Gaffin** (Columbia University/NASA GISS) used NASA satellite observations, weather-pattern data, and computer models to assess the effectiveness of strategies to reduce New York City's *urban heat island*.

Converging Satellites Unlock Hurricane Lili's Sudden Demise, January 30; *United Press International*. Using a fleet of NASA and other satellites, NASA-funded researchers, including **Pat Fitzpatrick** (Mississippi State University) were able to unlock the secret of Hurricane Lili's unexpected, rapid weakening as she churned toward a Louisiana landfall in 2002.

A Tiny Instrument Makes a Big Impact on Weather Forecasting, January 30; *CNetNews.com*, *BBS News*, *Science Daily*. Aircraft equipped with the NASA-developed Tropospheric Airborne Meteorological Data Report instrument are providing measurements of humidity, pressure, temperature, winds, icing, and turbulence that are improving weather models and forecasts, say researchers **Taumi Daniels** (NASA LaRC) and **Patrick Minnis** (NASA LaRC).

Climate Expert Says NASA Tried to Silence Him, January 28; *The New York Times*. **James Hansen** (NASA GISS) says the Bush administration has tried to stop him from speaking out since he gave a lecture last

month calling for prompt reductions in emissions of greenhouse gases linked to global warming.

2005 Warmest Year in Over a Century, January 26; *Associated Press*, *Reuters*, *Washington Post*. 2005 was the warmest year in over a century, according to research led by **James Hansen** (NASA GISS), who studied temperature data from around the world.

High Winds Rage Across Southland, January 24; *United Press International*, *Newsday*, *Los Angeles Times*, *Washington Times*, *KABC-TV* (Los Angeles). **Bill Patzert** (NASA JPL) discussed recent Santa Ana winds that fueled forest fires, destroyed homes, and disrupted air travel in California.

Interested in getting your research out to the general public, educators and the scientific community? Please contact Steve Cole on NASA's Earth Science News Team at scole@pop600.gsfc.nasa.gov and let him know of your upcoming journal articles, new satellite images or conference presentations that you think the average person would be interested in learning about. ■

Announcement: New MISR Order and Customization Tool Available

The NASA Langley Research Center Atmospheric Science Data Center (ASDC) and the NASA Jet Propulsion Laboratory (JPL) MISR teams announce the release of a new and innovative tool for ordering and customizing Multi-angle Imaging Spectroradiometer (MISR) data products.

This new MISR Order and Customization Tool provides a simple and intuitive interface to search and customize MISR data products. The new interface provides capabilities which enhance the ease of data usage. Tool functionality includes:

- Search by date or orbit
- Search via geographical map, latitude/longitude coordinates, or path
- Search for specific camera(s)
- Limit search results to latest file version
- Sort search results by date, path, orbit, camera, or file version
- Subset data by parameter
- Subset data via geographical map, latitude/longitude coordinates, or block
- Add applicable latitude/longitude layers
- Unpack and unscale data values
- Output data in original or conventional HDF-EOS formats

The Tool was tested on Windows 2000, XP (IE 6, Netscape 8 and 7.2, Firefox 1.5, Opera 8.5, and Mozilla 1.7), Mac OS X (Netscape 7.2), and Linux (Mozilla and Firefox).

To provide you with ever-improving service and to ensure we are meeting your data-ordering needs, we encourage comments and suggestions on the new MISR Ordering and Customization Tool.

l0dus01u.ecs.nasa.gov/cgi-bin/MISR_ordtool/main.cgi

For information regarding our data products or for assistance in placing an order, please contact:

Atmospheric Science Data Center
NASA Langley Research Center
Users and Data Services
Mail Stop 157D, 2 S. Wright Street Hampton, VA 23681-2199

Phone: 757-864-8656
E-mail: *larc@eos.nasa.gov*
eosweb.larc.nasa.gov

NASA Science Mission Directorate – Science Education Update

Ming-Ying Wei, mwei@hq.nasa.gov, NASA Headquarters
Theresa Schwerin, theresa_schwerin@strategies.org, IGES

NASA EARTH EXPLORERS: MAKING SENSE OF THE MAYAN COLLAPSE

What caused a 2,000-year-old empire to collapse in less than 200 years? The next *Earth Explorers* article features a trio of scientists using remote sensing to reveal secrets of the past, and help people avoid mistakes in the present. Look for NASA Earth Explorers at *www.nasa.gov/home* (click on the *For Students* link, and *Meet This Month's NASA Earth Explorer!* graphic). To access the full collection of Earth Explorers articles, go to *science.hq.nasa.gov/education/earth_explorers/*.

ON THE CUTTING EDGE: PROFESSIONAL DEVELOPMENT FOR GEOSCIENCE FACULTY 2006 WORKSHOP SCHEDULE

The National Association of Geoscience Teachers (NAGT)/Digital Library for Earth System Education (DLESE) *On the Cutting Edge* project helps geoscience faculty stay up-to-date with both geoscience research and teaching methods. The workshop series and website combine to provide professional development opportunities, resources, and opportunities for faculty to interact on-line and in person with colleagues around the world who are focused on improving their teaching. An integral aspect of the project is development of an expanding community of geoscience educators with a strong and diverse leadership. Most or all of the on-site workshop expenses (including lodging and meals) are covered for the workshops; participants or their departments pay for their travel to the workshop.

Visit *serc.carleton.edu/NAGTWorkshops/index.html* for the schedule and descriptions of workshops offered, deadlines, as well as resources on a variety of geoscience topics.

SCHOLARSHIPS AVAILABLE FOR SPACE FOUNDATIONS 2006 SUMMER INSTITUTES

Scholarships are available ($500 per course) to K-12 teachers for the U.S. Space Foundation's summer institutes and will be awarded on a first-come, first-served basis. Summer Institute courses can be applied towards salary increment, continued education credit, graduate credit, or a master's degree program at the University of Colorado at Colorado Springs or Regis University. The July 10 - 14 course is Earth Systems Science; other courses include Space Technology in the Classroom, Rocketry and the Biology of Living in Space, Space History and Space Law, and Biological and Physical Research

For more information, to apply for scholarship funding or register, call (800) 691- 4000 or visit *education.spacefoundation.org/si/*.

PROJECT 3D-VIEW (VIRTUAL INTERACTIVE ENVIRONMENTAL WORLDS)

Project 3D-VIEW (Virtual Interactive Environmental Worlds) combines NASA Earth-science mission data and three types of 3D learning technologies in a curriculum-based program for student explorers using 3D-viewers and the Internet. The project is designed primarily for Grades 5/6, and will create a virtual telepresence for students in each of the *spheres* of Earth science [biosphere, lithosphere, hydrosphere, atmosphere]. Additionally, a module on global climate change introducing Earth systems may be used with more-experienced students. The project helps students become knowledgable in life, land, water, and air systems, and be prepared for Earth-system-science topics and courses, and science-based decision making in high school and beyond. Using simple web interfaces on PC or Macintosh, students will explore, create, manipulate, and navigate 3D VRML (Virtual Reality) views. A major goal of *Project 3D-VIEW* is to increase the level of mathematic, scientific, and geographic literacy of students. The project is currently being piloted in 3 schools. To be put on an email notification list for a school to potentially participate in *Project 3D-VIEW*, e-mail *pilotschool@3dview.org*. For more information contact Project Director, Glen Schuster, *info@3dview.org.*

EARTH & SKY RADIO SHOWS
www.earthsky.com

NASA, NSF, and NOAA sponsor a series of Earth science shows on the *Earth & Sky* radio series. Each 90-second show is based on interviews with scientists and includes links to related websites. To find NASA articles, click on Radio Shows at the top of the page (*www.earthsky.com*), and then on Observing Earth, or click on *www.earthsky.org/shows/observingearth.php* to be taken directly to the Observing Earth page. *Earth & Sky* is heard by millions of listeners each day on more than 1000 commercial and public radio affiliates in the United States, on the Sirius and XM Satellite Radio networks, internationally by Podcast, and on dozens of

independent stations including American Forces Radio, World Radio Network, and Voice of America.

NEW ON-LINE WEATHER SERVICE FOR EDUCATORS
www.earthgauge.net

Earth Gauge, a program of the National Environmental Education & Training Foundation, is an information service designed to make it easy to explain the environmental impacts of weather events in cities across the U.S. Although the service was originally designed for weathercasters, teachers will find a wealth of factoids and tips about storm water and water quality, heat and air quality, and other topics that will be useful in the classroom. Users can browse weather/environment information by city, weather type, or environmental topic.

PROJECT LEARNING TREE RELEASES NEW ENVIRONMENTAL EDUCATION ACTIVITY GUIDE

Project Learning Tree has released its revised Pre-K-8 Environmental Education Activity Guide. Over the last three years, PLT undertook a comprehensive revision process to improve the existing Guide. There were six main goals addressed with the revision process, to include improving: reading connections; teacher support for differentiated instruction; assessment techniques; technology connections; content through updated issues, statistics, and facts; and the overall design of the Guide. To learn more about *Project Learning Tree* and how you can get a copy of this new edition, go to *www.plt.org*.

WHAT'S NEW ON THE NASA EARTH OBSERVATORY

Paleoclimatology: Climate Close Up
earthobservatory.nasa.gov/Study/Paleoclimatology_CloseUp/

While cave rocks and ice cores provide a long-term, annual record of the past, some other climate proxies can offer a detailed record of seasonal temperature or rainfall changes.

Paleoclimatology: The Ice Core Record
earthobservatory.nasa.gov/Study//Paleoclimatology_IceCores/

Ice sheets contain a record of hundreds of thousands of years of past climate, trapped in the ancient snow.

2005 WAS THE WARMEST YEAR IN A CENTURY
earthobservatory.nasa.gov/Newsroom/NasaNews/2006/2006012421540.html

The year 2005 may have been the warmest year in a century, according to NASA scientists studying temperature data from around the world.

NASA TO FLY INTO TROPICAL "PORTAL" TO THE STRATOSPHERE
earthobservatory.nasa.gov/Newsroom/NasaNews/2006/2006012321486.html

NASA scientists are leading an airborne field experiment to a warm tropical locale to take a close look at a largely unexplored region of the chilly upper atmosphere.

SPACE PROBES DETECT ENORMOUS NATURAL PARTICLE ACCELERATOR
earthobservatory.nasa.gov/Newsroom/NasaNews/2006/2006011121447.html

A fleet of NASA and European Space Agency space-weather probes observed an immense jet of electrically charged particles in the solar wind between the Sun and Earth. The jet, at least 200 times as wide as the Earth, was powered by clashing magnetic fields in a process called *magnetic reconnection*.

SCIENCE AND APPLICATIONS NEWS

For the latest NASA Earth science news, visit the NASA Earth Observatory, *earthobservatory.nasa.gov*, or Science@NASA, *science.nasa.gov*. Science@NASA stories are also available as podcasts, as well as translated into Spanish at their sister site, Ciencia@NASA, *ciencia.nasa.gov* ■

EOS Science Calendar

May 2-4
5th CERES Science Team Meeting, Williamsburg, VA. Contact Shashi Gupta, *s.k.gupta@larc.nasa.gov*

July 19-21
ESIP Federation Summer Conference, Lamont Doherty Earth Observatory, Palisades, NY. Contact: Carol Meyer, *carol.meyer@earthsciencefoundation.org.*

September 18
Aura Science Team Meeting and Validation Working Group Meeting. Contact: Anne Douglass, *Anne.R.Douglass@nasa.gov*.

September 20-22
SORCE Science Team Meeting, Orcas Island, San Juan Islands. Contact Vanessa George, *Vanessa.George@lasp.colorado.edu*; URL: *lasp.colorado.edu/sorce/meetings.html*

Global Change Calendar

May 1-3
Fourth GOES-R Users' Conference, Broomfield, Colorado. Contact: *Dick.Reynolds@noaa.gov*. URL: *www.osd.noaa.gov/announcement/index.htm*.

May 23-26
2006 AGU Joint Assembly, Baltimore, MD. URL: *www.agu.org/meetings/ja06/*

June 5-8, 2006
Workshop on Agricultural Air Quality: State of the Science, Potomac, MD. Contact Viney Aneja, Professor, Air Quality, North Carolina State University, *viney_aneja@ncsu.edu*. URL: *www.esa.org/AirWorkshop*

July 3-6
ISPRS Commission I Symposium, Paris, France. Call for Papers. Email: *isprs2006@colloquium.fr* URL: *www.colloquium.fr/sfpt2006.*

July 12-14
4th IEEE Workshop on Sensor Array and Multi-Channel Processing (SAM), Westin Hotel, Waltham, MA. URL: *www.sam2006.org*.

July 24-27
Western Pacific Geophysics Meeting, Beijing, China. URL: *www.agu.org/meetings/wp06/?content=program*

August 13-17
SPIE's Optics and Photonics 2006: Earth Observing Systems XI (OEI101) Conference, San Diego, CA. URL: *spie.org/conferences/calls/06/op/conferences/index.cfm?fuseaction=OEI101.*

September 17-23
Joint CACGP/IGAC/WMO Symposium: Atmospheric Chemistry at the Interfaces 2006, Cape Town, South Africa. Call for Papers. Contact: *brian@globalconf.co.za*. URL: *www.atmosphericinterfaces2006.co.za/*

September 25-29
2nd International Symposium on the Recent Advances in Quantitative Remote Sensing, Torrent, Spain. URL: *www.uv.es/raqrs/index.htm*.

November 7-8
2nd International Young Scientists' Global Change Conference, Beijing, China. URL: *www.start.org/links/announce_oppo/YSC_2006_Announce7.pdf*

November 9-12
Global Environmental Change: Regional Challenges, An Earth System Science Partnership, Global Environmental Change Open Science Conference, (IGBP, WCRP, IHDP, Diversitas), Bejing, China. URL: *www.essp.org/essp/ESSP2006/*

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