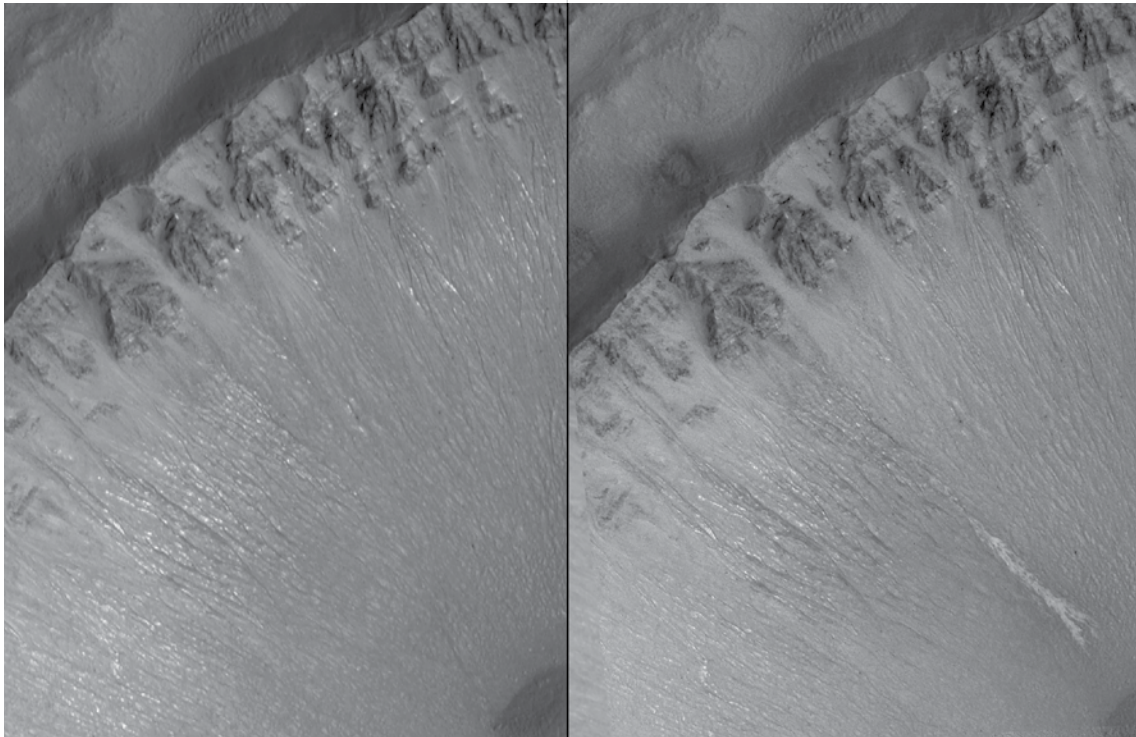


## 2006 IN REVIEW

By Mark Whalen



A gully as imaged by Mars Global Surveyor is shown at left in August 1999 and at right in September 2005. The images show the southeast wall of an unnamed crater in the Centauri Montes region. No light-toned deposit was present in August 1999, but appeared by February 2004. The new light-toned flow, by itself, does not prove that

liquid water was involved in its genesis. However, this observation and a similar light-toned flow in Terra Sirenum together show that some gully sites are indeed changing today, providing tantalizing evidence there might be sources of liquid water beneath the surface of Mars right now.

JPL has once again closed out the year in style. Less than a month after the announcement that Mars Global Surveyor has likely finished its operating career, the most productive Mars mission in history came through with the explosive news in December that its photographs have revealed bright new deposits in two gullies on Mars that suggest water carried sediment through them sometime during the past seven years.

In the meantime, the Laboratory continues its studies of the solar system and beyond, with 15 spacecraft, two rovers, seven science instruments and three Earth observatories all meeting or exceeding their requirements. Following are some highlights, chronologically, from 2006.



*Continued on page 2*

# 2006 IN REVIEW CONT'D



## JANUARY

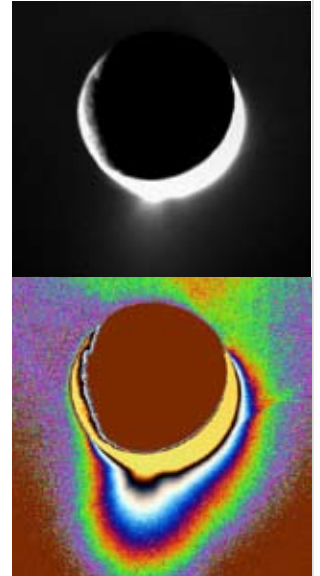
A new image from the **Galaxy Evolution Explorer** completed a multi-wavelength, neon-colored portrait of the enormous Cartwheel galaxy after a smaller galaxy plunged through it, triggering ripples of sudden, brief star formation. The false-color composite image shows the Cartwheel galaxy as seen by Galaxy Evolution Explorer in ultraviolet light (blue); the Hubble Space Telescope in visible light (green); the Spitzer Space Telescope in infrared (red); and the Chandra X-ray Observatory (purple). The Cartwheel is a monstrous 2.5 times the size of the Milky Way. ...



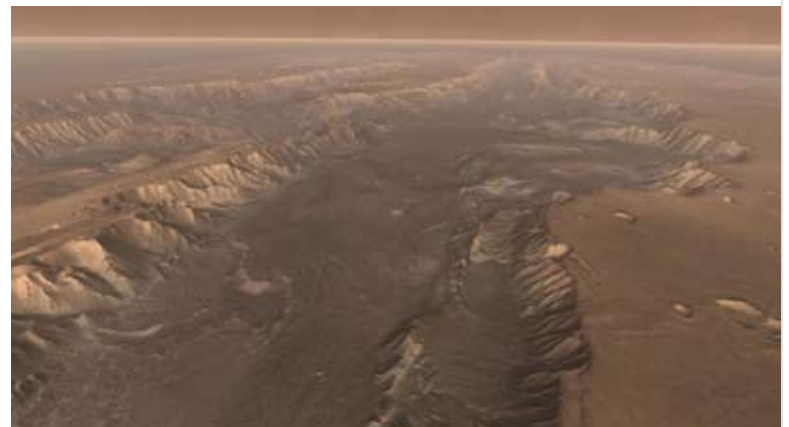
The **Stardust** sample return mission returned safely to Earth Jan. 15 when the capsule carrying cometary and interstellar particles successfully touched down at in the desert salt flats of the U.S. Air Force Utah Test and Training Range, delivering to the international science community material that has been unaltered since the formation of our solar system. A few days later, the science team observed thousands of impacts on the aerogel within the particle capture cells. ...

## MARCH

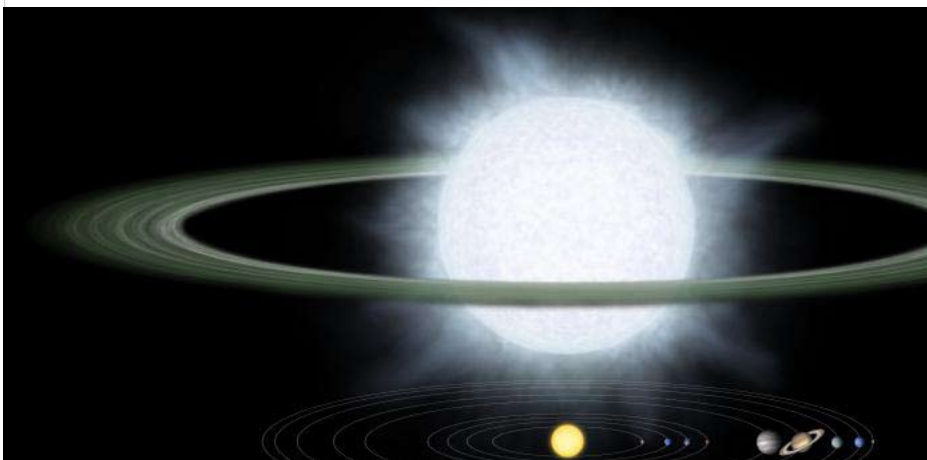
**Cassini** found what may be evidence of liquid water reservoirs that erupt in Yellowstone-like geysers on Saturn's moon Enceladus. The rare occurrence of liquid water so near the surface raises many new questions about the mysterious moon. "If we are right, we have significantly broadened the diversity of solar system environments where we might possibly have conditions suitable for living organisms," said Carolyn Porco, Cassini imaging team leader. ...



A new mosaic of Mars' Valles Marineris, the biggest canyon in the solar system, merged hundreds of photos from **Mars Odyssey**, offering scientists and the public an online resource for exploring the entire canyon in detail. ...



## FEBRUARY



**Spitzer** identified two huge "hypergiant" stars circled by monstrous disks of what might be planet-forming dust. The findings surprised astronomers because stars as big as these were thought to be inhospitable to planets. Dusty disks around stars may be signposts for present or future planetary systems. ...

Studies released in February showed the loss of ice from Greenland doubled over the last 10 years, as its glaciers flowed faster into the ocean in response to a generally warmer climate, and the entire Antarctic ice sheet's mass has decreased significantly from 2002 to 2005. The Greenland studies used data from Canadian and European satellites, while the Antarctica study was based on data from the **Gravity Recovery and Climate Experiment** (Grace). ...





# APRIL

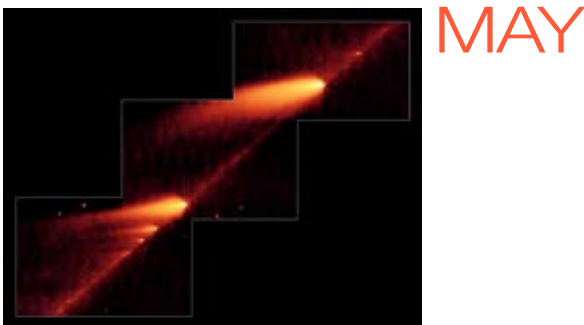
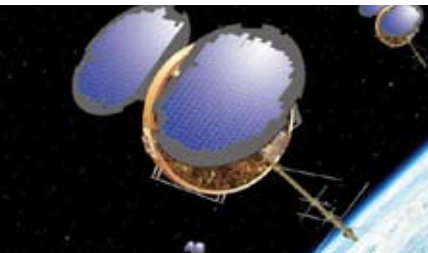
The **Cassini-Huygens mission team** was honored with an Aero-space Laurel award by the editors of Aviation Week & Space Technology magazine. Aviation Week presented the award for the successful land- ing of the European Space Agency's Huygens probe on Saturn's moon Titan, and for the science return and inspiring images from the Cassini orbiter. ...

A globe-spanning constellation of six weather and climate research satel- lites launched from Vandenberg Air Force Base April 14 on a five-year mission. The Constellation Observing System for Meteorology, Ionosphere and Climate network (Cosmic) is ex- pected to improve weather forecasts, monitor climate change and enhance space weather research. JPL de- signed **Cosmic's primary instru- ment**, a science global positioning system receiver, based on its proven BlackJack space receiver. "Cosmic is a prime example of transitioning NASA remote sensing technology into operational weather forecasting," said Tony Mannucci, supervisor of JPL's Ionospheric and Atmospheric Remote Sensing Group. ...

Two satellites were launched April 28 from Vandenberg Air Force Base on missions to reveal the inner secrets of clouds and aerosols, tiny particles suspended in the air. JPL's



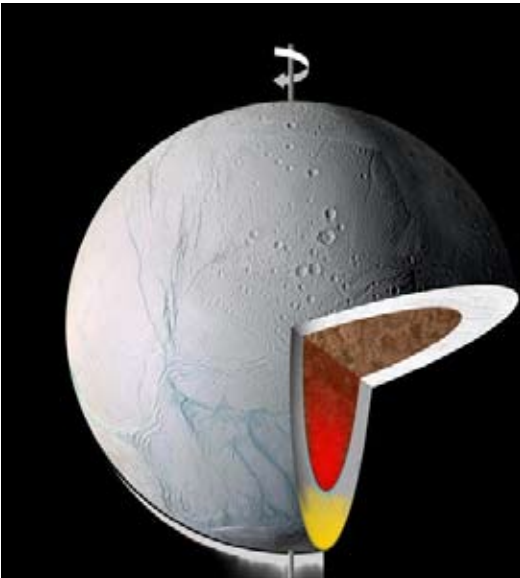
**CloudSat** mission, whose cloud-profiling radar is more than 1,000 times more sensitive than typical weather radar, was joined on its launch rocket by Calipso (Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations). The satellites will fly in formation in NASA's "A-Train" constellation, which also includes NASA's Aqua and Aura satellites and a French satellite called Parosol. ...



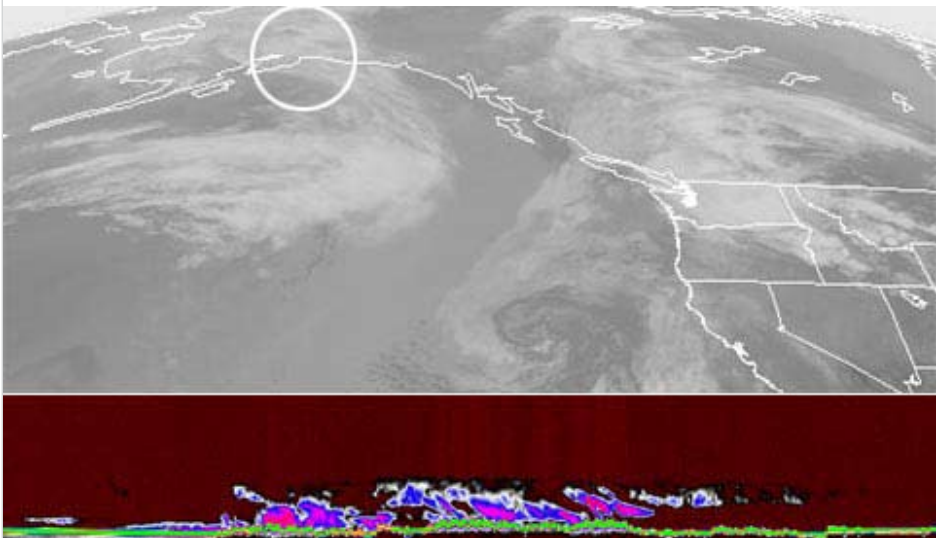
# MAY

**Spitzer** snapped a picture of the bits and pieces making up Comet 73P/Schwassman-Wachmann 3, which broke apart on its periodic journey around the sun. Spitzer's infrared eyes were able to see the dusty comet bits lining the trail because the dust is warmed by sunlight and glows at infrared wavelengths. Most of the dust particles, specifically the millimeter-sized nuggets, had never been seen before. ...

**Cassini** observed icy jets and plumes indicating active geysers spewing from Saturn's moon Enceladus—an active, icy world with an unusually warm south pole—may have performed an unusual trick for a planetary body. Research showed Enceladus rolled over, literally, explaining why the moon's hottest spot is at the south pole. "It's astound- ing that Cassini found a region of current geologi- cal activity on an icy moon that we would expect to be frigidly cold, espe- cially down at this moon's equivalent of Antarctica," said JPL planetary scientist Bob Pap- palardo. ...



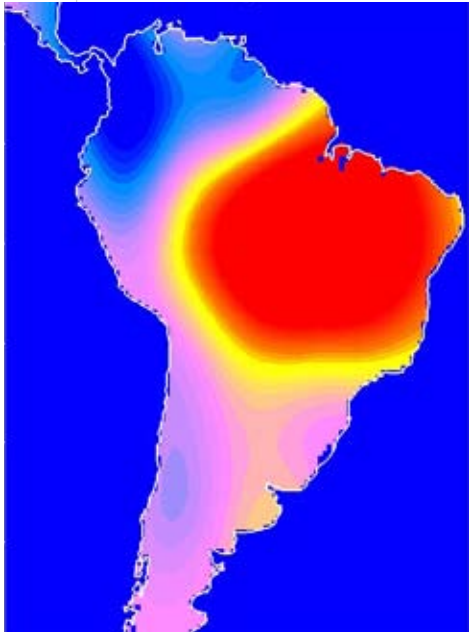
# JUNE



The first images from **CloudSat** revealed never- before-seen 3-D details about clouds. "We're seeing the atmosphere as we've never seen it before," said CloudSat Project Manager Deborah Vane. "We're no longer looking at clouds like images on a flat piece of paper, but instead we're peering into the clouds and seeing their layered com- plexity." ...

University scientists using **Global Positioning System (GPS)** software developed by JPL showed that GPS can determine, within minutes, whether an earthquake is big enough to generate an ocean-wide tsunami. "This technique improves rapid estimates of the true size of great earthquakes and advances real-time tsunami modeling capabilities," said JPL geologist Frank Webb. ...

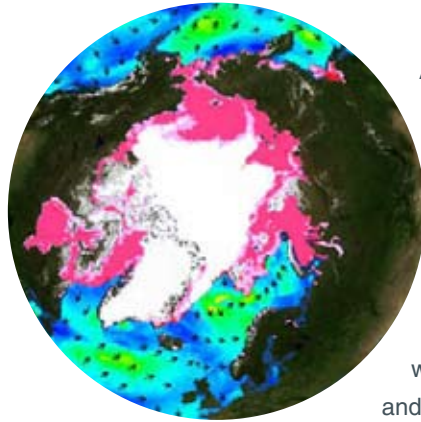
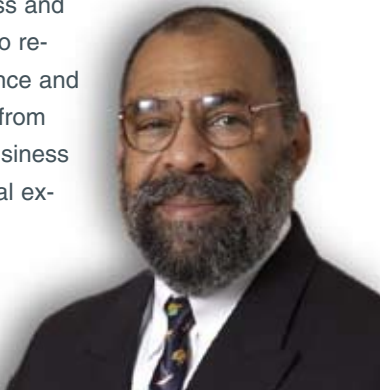
## JULY



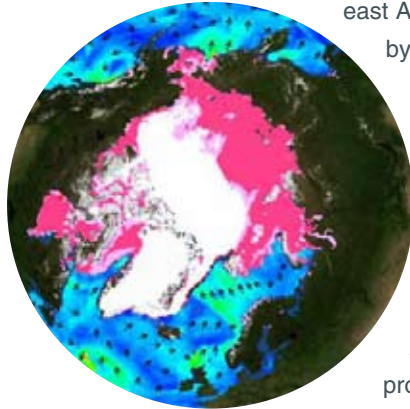
Scientists using space-based measurements directly monitored and measured the complete cycle of water movement for an entire continent. Using data from **Quick Scatterometer** (QuikScat), **Gravity Recovery and Climate Experiment** (Grace) and **Tropical Rainfall Measuring Mission** (TRMM), a JPL science team observed the seasonal cycling of water into and out of South America. The findings are significant because until now there had been no direct way to monitor continental water balance. ...

**Tom May**, manager of JPL's Business Opportunities Office and Supplier Diversity Program, was selected as one of the year's 50 influential minorities

in business by the Minority Business and Professional Network Inc. May, who received the 2006 Award for Excellence and Leadership, was one of 50 people from the federal, corporate and small business sector honored for their professional excellence and strong leadership. ...



A team led by Son Nghiem of the Polar Remote Sensing Group used JPL's **QuikScat** satellite to measure the extent and distribution of perennial and seasonal sea ice in the Arctic. While the total area of all **Arctic sea ice** was stable in winter, the distribution of seasonal and perennial sea ice changed significantly. "If the seasonal ice in the east Arctic Ocean were to be removed



by summer melt, a vast ice-free area would open up," said Nghiem. "Such an ice-free area would have profound impacts on the environment, as well as on marine transportation and commerce." ...

A NASA and university study provided unique insights into the sources of pollutants in Earth's atmosphere and how they are transported around the world. For the first time, researchers used simultaneous observations of carbon monoxide and ozone from space to differentiate between ozone produced from human activity and from natural sources. The observations were obtained from JPL's **Tropospheric Emission Spectrometer instrument** onboard NASA's Aura satellite. ...

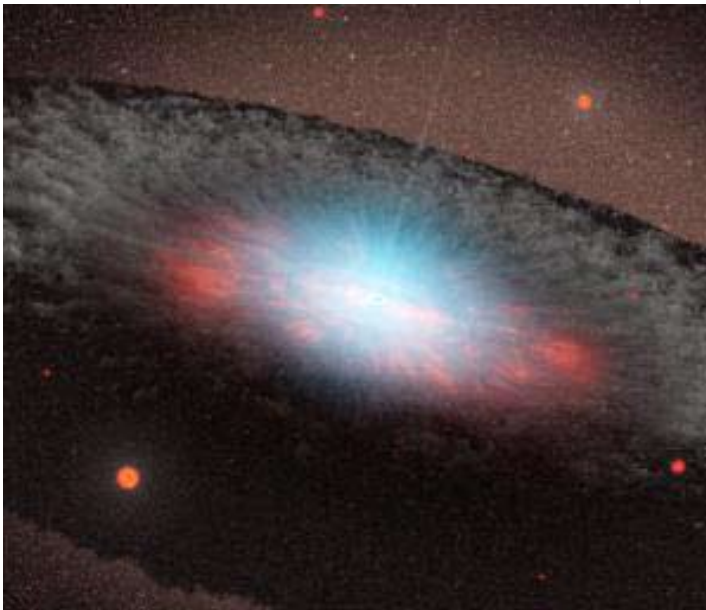
## SEPTEMBER



## AUGUST

A new image from **Spitzer** probed deep into the clouds of dust that permeate the Orion nebula and its surrounding regions. The striking false-color picture showed pinkish swirls of dust speckled with stars, some of which are orbited by disks of planet-forming dust. Spitzer's powerful infrared vision was able to unearth nearly 2,300 such planet-forming disks in the Orion cloud complex. ...

The **Galaxy Evolution Explorer** surveyed more than 800 nearby elliptical galaxies of various sizes. An intriguing pattern emerged: the more massive, or bigger, the galaxy, the less likely it was to have young stars. Because bigger galaxies are known to have bigger black holes, astronomers believe the black holes are responsible for the lack of youthful stars. The findings indicate that supermassive black holes in some giant galaxies create such a hostile environment that they shut down the formation of new stars. ...





## OCTOBER



**Cassini** released a new view of Saturn that revealed previously unknown faint rings. This panoramic view was created by combining a total of 165 images taken by the Cassini wide-angle camera. ...

JPL Director **Charles Elachi** was honored as one of “America’s Best Leaders” by U.S. News & World Report, in collaboration with the Center for Public Leadership at Harvard University’s John F. Kennedy School of Government. The award praised leaders who embody and define leadership and have achieved measurable results in their fields, challenged established processes and inspired a shared vision. The committee was particularly seeking leaders with resilience, adaptability and sustainability who empower others and value their colleagues’ personal growth. ...

An image from **Mars Reconnaissance Orbiter’s** High Resolution Imaging Science Experiment shows “Victoria crater,” an impact crater near Mars’ equator. Layered sedimentary rocks

are exposed along the inner wall of the crater, and boulders that have fallen from the crater wall are visible on the crater floor. Five days before this image was taken, Opportunity arrived at the rim of Victoria crater; the rover can be seen in this image, at roughly the “10 o’clock” position along the rim of the crater. ...



A giant black hole was caught red-handed dipping into a cosmic cookie jar of stars by the **Galaxy Evolution Explorer**. This is the first time astronomers have seen the whole process of a black hole eating a star, from its first to nearly final bites.



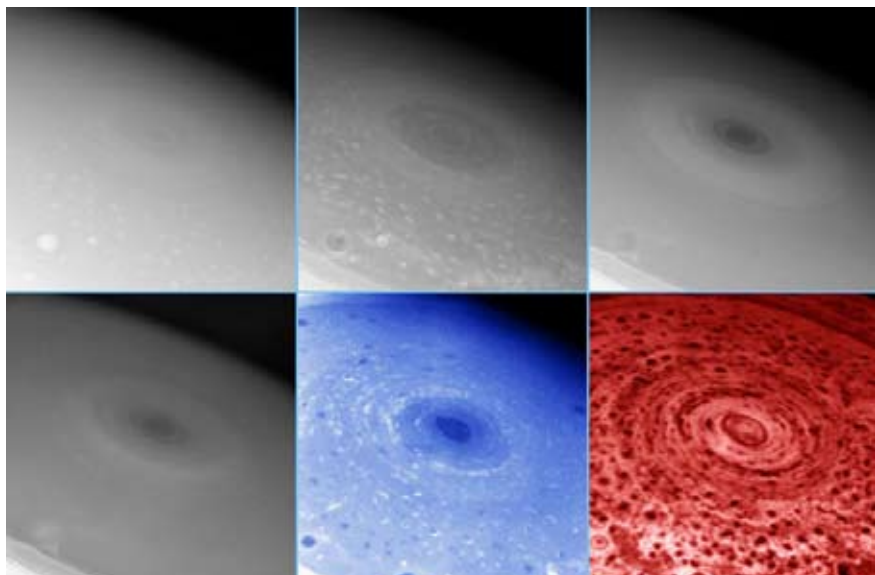
... While most of the new impact craters found on Mars by the **Mars Global Surveyor’s** Mars Orbiter Camera have dark ejecta patterns, a few of them also have light-toned ejecta, indicating that the impacting meteorite excavated to a depth where a light-toned material was present. ...



## DECEMBER

## NOVEMBER

**Cassini** saw something never before seen on another planet—a hurricane-like storm at Saturn’s south pole with a well-developed eye, ringed by towering clouds. The “hurricane” spans a dark area inside a thick, brighter ring of clouds. It is approximately 8,000 kilometers (5,000 miles) across, or two-thirds the diameter of Earth. ...



# Space Technology

1 2 3 4 5 6 7 **8**



Demonstration  
mission is  
paving the  
way for  
the future

By Mark Whalen

Photos by Tom Wynne / JPL Photolab



Rewards don't come without risks, and right now JPL is on the fast track to preparing a mission that balances the risks of the unknown with the possibilities for great payoffs for the future of exploration.

The next mission in NASA's New Millennium Program, the JPL-managed Space Technology 8, an Earth orbiter that seeks to validate four new subsystem-level technologies never flown in space, successfully completed its confirmation review and has received a go-ahead from NASA Headquarters for implementation.

The seven-month mission is scheduled for launch in February 2009.

"We've finished formulation phases A and B, which is where you define the project, come up with a budget and develop a schedule," noted Project Manager Mary Bothwell. "Phases C, D and E are the implementation phases, which means we are ready to build it, test it and fly it."

Space Technology 8 doesn't represent the typical JPL mission.

"On JPL's long-duration, deep-space missions, we are busy trying to adjust the vehicle to accommodate the science instruments," said project systems engineer Richard Bennett. "With ST8, we're doing the exact opposite—we adjust the experiments to accommodate the vehicle."

The four technologies that comprise the mission:

- The UltraFlex-175 experiment, an ultra-lightweight solar panel array deployed on a mesh support system, meant to provide a significant advancement in power-to-mass performance over existing state-of-the-art for high-power arrays.
- The Sailmast, an ultra-lightweight graphite mast intended for solar sail propulsion systems but also for missions that need to place a sensor a long way from the spacecraft. The deployable boom is 40 meters (about 130 feet) long and weighs 1.6 kilograms (about 3.5 pounds).
- The Dependable Multiprocessor, which will provide onboard high-rate parallel processing for science data and autonomous control functions using commercial-off-the-shelf processors. The system includes software to detect and correct radiation-induced errors.
- The Thermal Loop experiment, designed to efficiently cool small spacecraft and small instruments with one cooling loop that may have different heat loads on various parts of it. This new technology will not only save mass but it will also allow greater design flexibility in deciding where components are placed. It will also minimize—if not eliminate—the need for supplemental electrical heaters.



*From left: Mary Bothwell,  
Art Chmielewski, Khanara  
Ellers, Steve Franklin,  
Richard Bennett.*

JPL feels comfortable with the heritage-proven spacecraft provided by contractor Orbital Sciences Corp. The spacecraft bus is actually a combination of two Orbital product lines—MicroStar avionics and a LeoStar structure—noted flight system manager Steve Franklin, who oversees spacecraft bus and experiment integration. MicroStars have flown successfully more than 40 times.

“ST8 is a fast-moving, low-cost mission, meaning we have to accept reasonable and carefully calculated risks,” said Franklin.

In the tradition of the New Millennium Program, “We look at lessons learned from all missions in trying to figure out how to do or not do things,” said Bothwell. “In this case, Orbital’s experience is something that helps us address the risk. We need to understand the risks we’re taking and then satisfy Lab management and the chief engineer’s office that we really do understand what we’re going to build and that it meets the requirements we promised NASA.”

Space Technology 8 payload manager Art Chmielewski praised the New Millennium Program manager, Chris Stevens, for providing the mission with funding for its own spacecraft and launch vehicle. Chmielewski is also project manager for New Millennium’s Space Technology 6, which developed two technologies: the Autonomous Sciencecraft Experiment and the Inertial Stellar Compass. “For ASE we investigated 131 different NASA and Department of Defense missions before we found a ride,” he said. The Inertial Stellar Compass also bounced among different carriers. “At one time our best chance was to fly on a private spacecraft carrying human ashes into space. I love the comfort of Space Technology 8’s own ride to space.”

Another improvement brought into Space Technology 8 from Space Technology 6’s experience is the New Millennium Program technology review board, led by Jack Stocky. “Jack found world experts who help us decide if a given technology is mature enough for flight and what to demonstrate in space to infuse it into future missions,” said Chmielewski. “We are thrilled that ST6’s Autonomous Sciencecraft Experiment was immediately adopted by the Mars Exploration Rovers to look for clouds on Mars.”

One of the challenges for mission assurance manager Khanara Ellers and her team is to keep from cutting corners due to schedule and cost pressures.

Ellers is familiar with Orbital, having worked with the company in preparing the Dawn mission for development. “Orbital has very good processes and is very focused on building spacecraft buses. We are working with them to look at the bigger picture; we need to help them be our system integrator as well.”

“It’s very exciting to be involved in demonstrating technology that will enable future missions,” said Bennett. “It’s a series of costs and technical/engineering tradeoffs. The key is to build relationships with team partners, motivate them to be active and engaged. By teleconference, we have multiple technical working group meetings that cover software, mission operations, risk identification and management.

“We are trying hard to stress that system engineering and mission assurance should be viewed as an integrated approach. The combination lends itself to a better design.”

The team faces a series of critical design reviews starting in the spring next year. The fast-paced mission will see only about eight months pass between the project preliminary design review and the spacecraft critical design review, then another seven months to the start of spacecraft integration and test.

Bothwell said the total workforce will be about 70 JPL full-time equivalents over a four-year period. “The highest we’ll get to is 21 JPL full-time equivalents in fiscal year 2008, which is the year we’re going to be integrating everything on the spacecraft,” she said. Most of the JPL support, provided by Divisions 31, 34 and 35, will be in project systems engineering, flight systems and payload management. About 11 JPLers will be on staff for launch.

Bothwell pointed to Deep Space 1, JPL’s New Millennium mission that successfully demonstrated ion engine propulsion, for inspiration. “Nobody in the scientific world wanted to use it until it was proven,” she said. “Deep Space 1 took the risk out. Hopefully we can do the same thing.

“We want to develop a robust system so that future project managers and future science experimenters can say ‘Wow! ST8 proved it and we now can use this technology with confidence.’”



# News Briefs



Gerard Holzmann

## Holzmann receives Netherlands honors

Gerard Holzmann, lead technologist for JPL's Laboratory for Reliable Software, recently received an honorary doctorate from the University of Twente in the Netherlands.

Holzmann accepted the award at the university during an international workshop on advances in model checking, held in his honor.

The university's directorate board bestows the honor every five years to candidates who make an outstanding contribution to science and/or promote the cause of science from a prominent position, or to candidates responsible for applications in his or her scientific field with important societal consequences.

Holzmann, who joined JPL in 2003, earned a master's degree in electrical engineering and a doctorate in technical sciences from Delft University of Technology, the Netherlands.

## Aviation Week kudos to Stardust

JPL's Stardust mission is a co-winner of the 2006 Aviation Week and Space Technology Program Excellence Award.

More than 300 federal programs were reviewed in consideration of the award. The Atlas launch vehicle program was the other co-winner.

Stardust Project Manager Tom Duxbury, former Project Manager Ken Atkins and Lockheed Martin Space Systems Stardust Program Manager Joe Vellinga accepted the award in ceremonies last month.



Cinzia Zuffada

## Associate chief scientist appointed

Cinzia Zuffada, former manager of the Remote Sensing Science Section, has been named JPL's associate chief scientist.

Zuffada joined JPL in 1992 in the Communications Engineering and Science Division. She moved to the Earth and Space Sciences Division in November 2002, where she served as deputy manager of the Remote

Sensing Science Section, and in April 2006 she became section manager. In this capacity she championed the development of collaborations between the external Earth climate community and JPL, and has represented the Science Division in a number of inter-divisional working groups advocating for scientific research on Lab.

Zuffada's research interests lie in modeling the electromagnetic properties of the Earth's atmosphere, as well as rough sea and ocean surfaces, to understand the characteristics of GPS signals scattered by such media. At JPL she has had lead roles in developing analytical and numerical methods for solving large-scale electromagnetic problems, ranging from scattering and radiating structures to modeling optically large particles in planetary atmospheres.

She has played a pivotal role in demonstrating the feasibility of GPS altimetry measurements from fixed sites and airplanes, has acquired international recognition and is active in chartering future technology developments. Also, she has lectured at Italian universities on her key role in the development of the combined finite-element integral-equation technique for scattering and radiation modeling of large complex systems, including conformally mounted arrays.

# Passings



**James Clawson**, 67, former manager of JPL's Reliability Office, died Nov. 16.

Clawson joined JPL in 1985, after spending 18 years at the Johnson Space Center as a thermal control team leader for the space shuttle program and working on thermal analysis of the Apollo lunar program. At JPL, he served as mission assurance manager for the Mars Pathfinder Project during spacecraft development. He was also technical group supervisor of the Thermal Environments Group.

Among his honors, Clawson received NASA's 1997 "Best of the Best" Quality Assurance Special Achievement Recognition (QASAR) award for his leadership in the implementation of innovative, low-cost engineering approaches for the Mars Pathfinder mission. He also received a NASA Exceptional

Achievement Medal in 1998.

Clawson retired in 2003. He is survived by his wife, Mary.

**William Bollinger**, a retired optical alignment specialist, died Oct. 30.

Bollinger started with JPL in 1953 in the White Sands, New Mexico, facility. He moved to Barstow in 1958 to assist in the development of Goldstone Deep Space Communications Complex.

Bollinger retired in 1983. He is survived by his wife, Stella; children Cindy, Mike, Dianna, Billy and Lori; 10 grandchildren and two great grandchildren.

Section 314 retiree **Fred Gangloff**, 73, died Nov. 1.

Gangloff worked at JPL from 1986 to 2001. He is survived by his sister Gloria and brother David.

Services were held Nov. 14 in Hermon, Calif.

**Charles Savage**, 85, a retired technical group manager, died Nov. 6.

Savage joined JPL in 1966 and retired in 1985. He is survived by his wife, Dorothy; sons Robert and Donald; daughter Karen; and three grandchildren. Services were held in Temple City.

# Letters

My sincere gratitude to my friends and colleagues for the thoughts, prayers, support and generosity shown to me during my illness. My family and I appreciate all of you so much.

*Mary Kay Kuehn*

My family and I wish to thank our friends at JPL for their kind words and show of support at the passing of my father, Chuck. It has meant a lot to all of us, and has made an otherwise difficult time more bearable. Your warmth will long be remembered.

*Bill Shinbrot*

My family and I very much appreciate the expressions of condolence I have received from my JPL colleagues and friends at the passing of my mother. The flowers, cards, thoughts and prayers made a big difference for us. I thank you all for your kindness, generosity and understanding at this difficult time.

*Jan Martin*

I would like to sincerely thank all my "JPL family" of friends and co-workers for all their support to me during a lengthy illness and recent passing of my

mother. I don't know what I would have done without all your kindness, support, and expressions of comfort. Thank you also to ERC for the lovely plant. All of this has been greatly appreciated and will be remembered.

*Ann Hall*

To our JPL friends and colleagues: Cindy and I wanted to thank you all for your thoughts and condolences, along with the lovely plant sent to me, in sympathy for the recent passing of my father, Joseph. We appreciate your kind words and cards.

*Peter and Cindy Kahn*

# Retirees

The following JPL employees retired in December:

**Ronald Ross**, 38 years, Section 354.

**Raymond Jurgens**, 33 years, Section 332F.



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