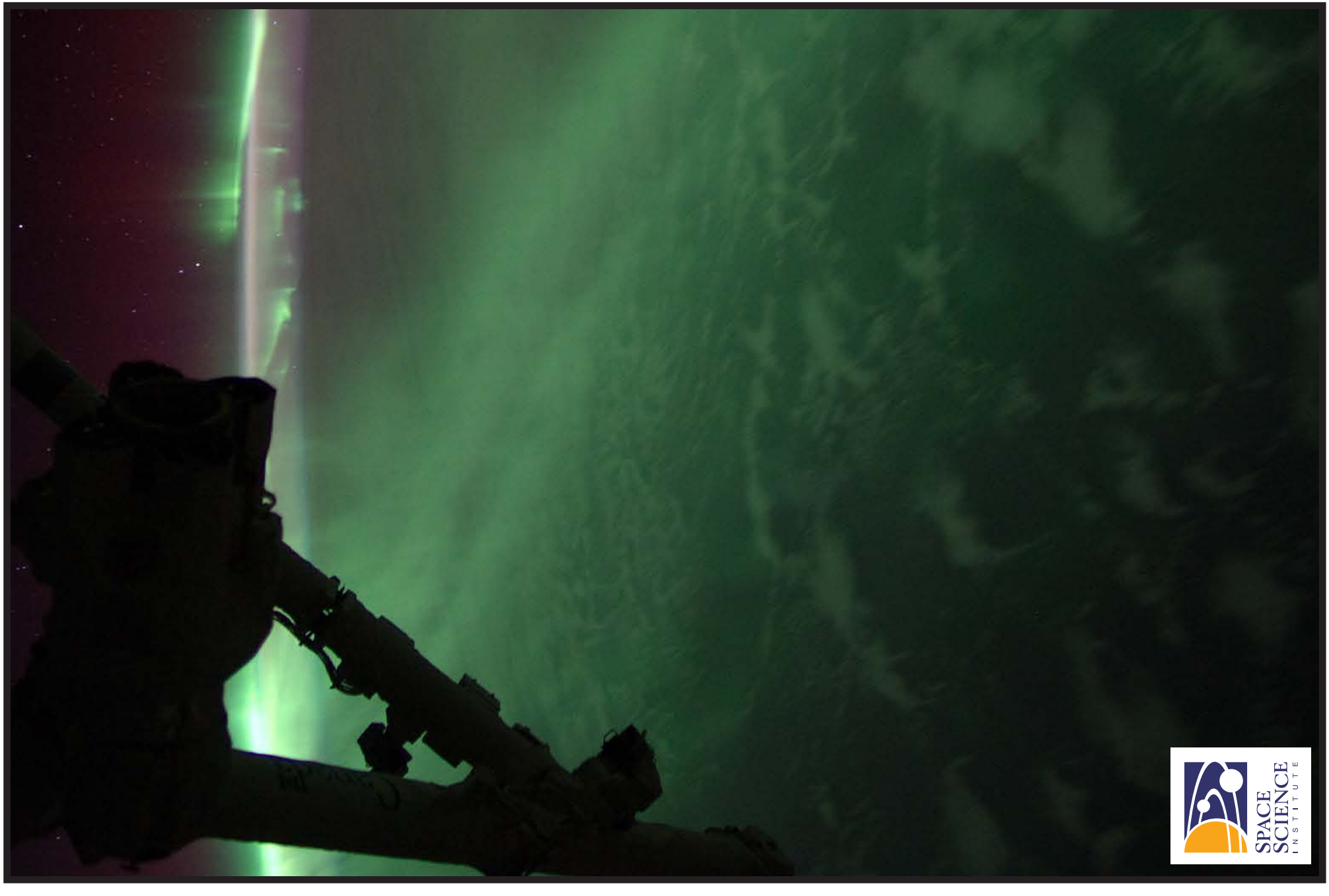
Space Science Institute . 4750 Walnut Street . Suite 205 . Boulder, Colorado 80301 . 720.974.5888 . www.spacescience.org

ANNUAL REPORT 2011



MESSAGE FROM THE DIRECTOR

Inspire. Explore. Discover. These words describe our efforts in both scientific research and education. In fact, they define the essence of our mission: to integrate world-class research with an innovative education program within a single institution. The guidance and vision of the Board, along with that of our senior management team, have created an environment that draws world-class scientists to the Institute and enables us to develop education and outreach programs that benefit millions of people worldwide. Two new board members joined in 2011: Dr. Marilyn Johnson (Science Director, Oregon Museum of Science and Industry) and Maddie Zeigler (Principal, GrantWriting Consultant Services). SSI's 2011 revenues were $6.1M, a 14.6% increase from 2010.

SSI has a robust scientific Research Branch (Director, Dr. Michael Wolff) with scientists participating in robotic missions such as the Mars Exploration Rovers, in flight missions such as Spitzer and SOFIA, and in ground-based observation programs using facilities located all over the world. Three new researchers joined the Research Branch last year: Padma Yanamandra-Fisher (Research Scientist, Rancho Cucamonga, CA office), Di Li (Research Scientist, La Verne, CA office), and John Podesta (Research Scientist, Punta Gorda, Fl office). Congratulations go to Ben Clark (Senior Research Scientist, Littleton, CO office) who received the Harold Masursky Award on October 3, 2011 at the Division of Planetary Sciences Meeting in Nantes, France. This prestigious award acknowledges Ben's outstanding service to planetary science and exploration, having played an integral role in many NASA planetary missions over the years.

SSI's Flight Operations Branch (Director, Dr. Carolyn Porco) is home to the Cassini Imaging Central Laboratory for Operations (CICLOPS). CICLOPS is the center for uplink and downlink operations for the imaging science experiment on the Cassini mission to Saturn. Cassini's landmark exploration of the ringed planet, its mysterious moons, stunning rings, and complex magnetic environment will continue through 2017 when the spacecraft's third and final mission will come to an end. CICLOPS team members and the Cassini mission scientists and engineers are now hard at work executing the seven-year Cassini Solstice Mission, the second extension beyond Cassini's prime mission (which ended in 2008).

SSI's National Center for Interactive Learning (Director, Dr. Paul Dusenbery) is organized around five interconnected groups: 1) Exhibition Development, 2) Digital Learning, 3) Professional Development, 4) Community Outreach, and 5) Learning Research and Evaluation. In 2011, the NCIL team launched the national traveling exhibition *Great Balls of Fire: Comets, Asteroids, and Meteors* (supported by NSF and NASA). The *Discover Earth: A Century of Change* library exhibit (part of the NSF-funded STAR_Net project) opened in the Fall at the Louisville Public Library in Colorado.

In 2011, SSI hired two development consultants to explore the internal and external factors that would impact our development and fundraising plans. Their report was accepted by the Board in August and implementation has begun. The report included both short-term and long-term objectives, strategies, and revenue/expense projections. SSI's headquarters, located in Boulder, CO, supports our continuing collaborations and strong relationships with a number of the key research, education, and aerospace organizations, including the University of Colorado, NOAA's Space Weather Prediction Center, National Center for Atmospheric Research, Lockheed Martin, and Ball Aerospace. However, our impact goes far beyond Colorado. We seek and encourage strong ties to corporations, foundations, and institutions nationwide. Come join our voyage of discovery.

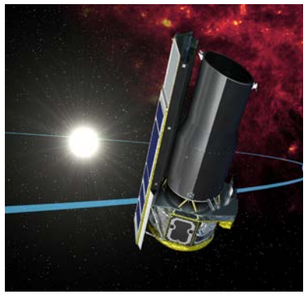
Paul B. Dusenbery, Executive Director

OUR MISSION

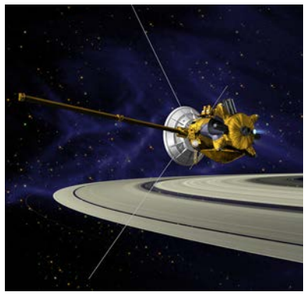
The Space Science Institute addresses 21st century challenges by advancing scientific understanding of Earth and the Universe; engaging the public in science-technology learning opportunities; and inspiring youth to pursue science-technology careers.

OVERVIEW

RESEARCH



FLIGHT OPS



NCIL

The Space Science Institute (SSI) is a nonprofit, public benefit 501(c)(3) corporation founded in 1992. SSI has five major branches: Research, Flight Operations, National Center for Interactive Learning, Business Operations, and Information Systems and Technology (IST). SSI is on the leading edge of creating new, affordable, efficient, and far-reaching models for earth and space science research, and science, technology, engineering, and mathematics (STEM) education. In the coming years, our potential to make science accessible to large numbers of people, including underserved communities, is enormous. The key to our approach is that we offer the full continuum of discovery and education – we conduct world-class scientific research and we make it accessible to a broad population.

Humans are driven to explore. We are inspired by fundamental questions: Are we alone? Could we live on other planets? How does our amazing planet work? Few things capture our imaginations more than the mysteries of space and the wonders of our own planet. Society benefits from the pursuit of new knowledge: the search for life beyond Earth begins with understanding how our own planet works. The excitement of earth and space science offers a compelling hook for engaging the public in science and inspiring a new generation of innovators.

SSI is responding to a crisis in research, public science literacy, and STEM education.

Discovery and invention are the keys to a healthy and prosperous future and science has a critical role to play. The future of science and engineering in the United States depends heavily on:

- A strong research infrastructure.
- A scientifically literate populace that supports investment in research.
- A pipeline of future research scientists and engineers.

Today, all three are weak. Despite the fact that 70% of the engineering workforce will retire within the next ten years, our universities are graduating many more visual arts and performing arts majors than engineers. Traditional research institutions are struggling under the pressures of a poor economy and an aging infrastructure. At the same time, the public's overall science literacy is shockingly low. Many do not understand the scientific process. In 2009, our children ranked 31st out of 56 developed countries in mathematics. In short, we are no longer leading other nations; instead, we are falling behind them.

We INSPIRE

SSI is in the "inspiration" business. The impact of our research and education programs is increased access to STEM learning for an audience that is cross-generational and often underserved. We don't know who will be inspired to become a scientist, engineer, flight operations specialist, or maybe just a person who reads the paper with interest every day. What we do know is that our programs have the potential to ignite their curiosity and motivate them to continue learning.

Cover Image :: Aurora from ISS. Credit: NASA
Inside Cover Image :: Stately Saturn. Credit: NASA/JPL/SSI
Image Page 30 :: The Blue Planet. Credit: NASA
Above :: (Top) An artist's schematic of the Spitzer spacecraft. Credit: NASA/Spitzer, (Middle) The planet Saturn. Credit: NASA/JPL/SSI, (Bottom) A family visits the Giant Worlds exhibit. Credit: NCIL/SSI

We DISCOVER

In today's marketplace of ideas, SSI has pioneered remote employment in our research fields, a mode that has been particularly conducive to supporting researchers and, in turn, promoting discovery. In this environment, our science thrives. Scientists in our Research Branch are participating in robotic missions to Mars and Saturn and in space observatory missions such as Spitzer and Hubble. Our Flight Operations Branch is home to the Cassini Imaging Central Laboratory for OperationS (CICLOPS). Led by Cassini Imaging Team leader Dr. Carolyn Porco, fourteen scientists from the United States and Europe are deepening our knowledge about Saturn and the processes by which planets – and whole planetary systems – form and develop.

We EDUCATE

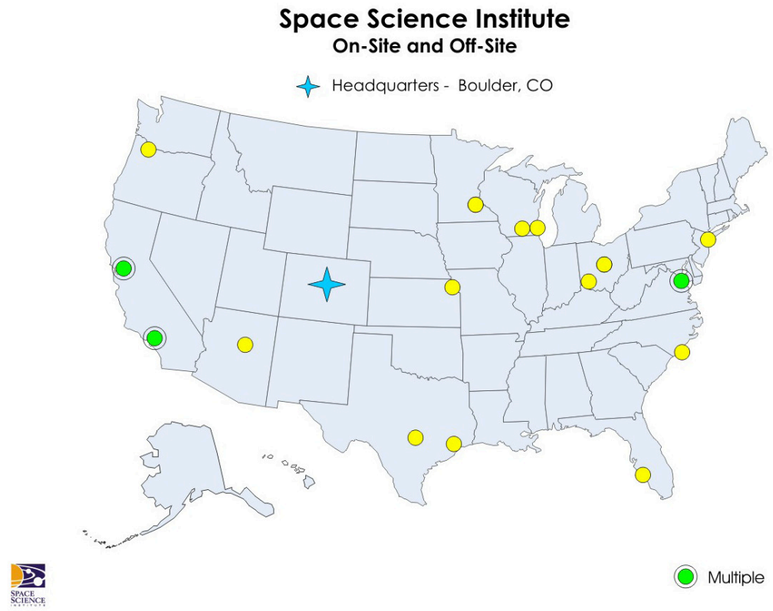
Providing high quality STEM learning opportunities for all Americans is essential to creating an educated citizenry who understand the complex issues confronting our nation and the world. STEM professions and the pipelines that produce those professionals lack ethnic diversity, even as the nation is undergoing a significant demographic shift. SSI's National Center for Interactive Learning is leading the way for a new generation of STEM education platforms that will make science accessible to new audiences. We foster collaboration between scientists and educators to bring the wonder of discovery directly to people wherever they are already engaged. We bridge the worlds of public schools, libraries, museums, and the Internet

Thank You

SSI acknowledges the 2011 grants and contracts from the following organizations:
NASA, NSF, JPL, STScI, UCLA, University of Arizona, SETI, Chabot, USRA ,Ideum, Science Systems and Applications, Inc (SSAI)

SSI also wishes to thank the generous individuals and corporations who contributed to the Space Science Institute in 2011:
Grantwriting Consulting Services, Inc., Dr. Paul & Michele Dusenbery, Green & Associates, LLC, John & Eva Nagy, Dr. Marilyn Johnson ,Lockheed Martin, Ball Aerospace

The map below shows where SSI employees are located in the United States during 2011.



2011 Board Members:

Paul Dusenbery, Chair & Executive Director, Space Science Institute
Dick Green, Former CEO of CableLabs and Business Consultant
Marilyn Johnson, VP, Oregon Museum of Science and Industry
Steve Jolly, Systems Engineering Director, Lockheed Martin Corporation
John Nagy (Treasurer), CFO, Dumb Friends League, Denver
Bill Purcell (Secretary), Senior Manager Advanced Systems, Ball Aerospace
Maddie Zeigler, Education Consultant

RESEARCH

SSI's Research Branch scientists participate in a broad array of space science activities, including earth science, space physics, planetary science, and astrophysics. Our research team's expertise continues to expand, and now encompasses investigations of phenomenon on Earth, on the Sun and in the solar wind, in atmospheres and on surfaces of other bodies in our Solar System, in our galaxy—including the early stages of the life cycles of stars and nascent planetary systems around other stars—and beyond: quasars and other types of distant galaxies.

SSI researchers are closely connected to the operations of current astrophysical space facilities such as the SOFIA airborne observatory, and the Kepler, Spitzer, and Hubble Space Telescopes. Closer to home, several SSI researchers focus on Mars research through active participation in the ongoing Mars Exploration Rovers and Mars Reconnaissance Orbiter missions, as well as the upcoming Mars Science Laboratory (arriving at Mars in August 2012).

Above :: An artist's schematic of the formation of a solar system. Credit: NASA/Spitzer

SSI's off-site and on-site researchers form a network of naturally entrepreneurial scientists who support themselves through a mixture of grants and contracts. Our organization and infrastructure allow for dynamic, collaborative efforts among individuals in fields of research that are typically separated in academic institutions. In this spirit, we continue to search out options for new and creative opportunities to increase the health and vitality of our Research Branch.

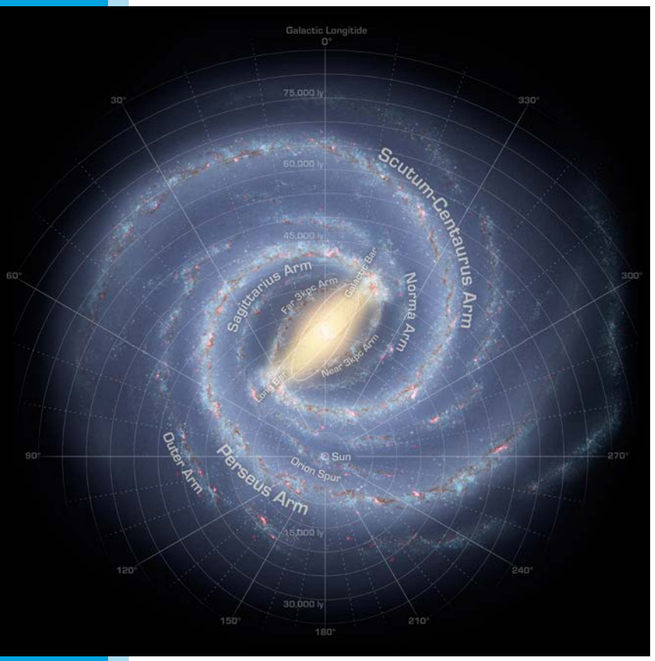
SSI's Off-Site Research Option

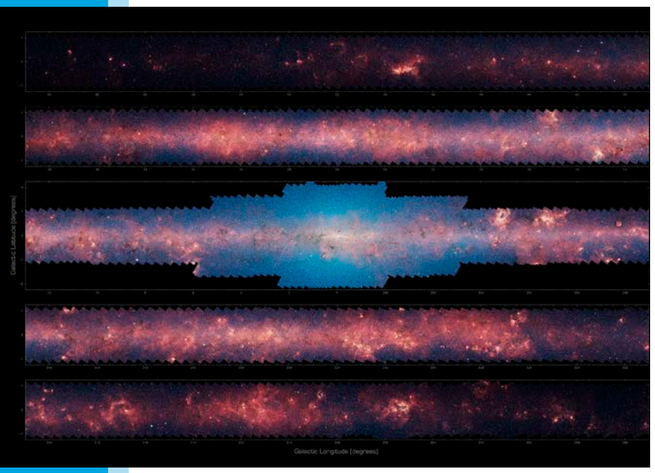
SSI is one of the pioneers in remote employment for whom the traditional university or research center is not a viable option. The long-distance nature of most scientific collaborative research lends itself well to the option of remote employment. Access to significant computational resources no longer requires large institutional support. Furthermore, most academic journals and professional proceedings are fully accessible through digital subscriptions, greatly mitigating the need for institutional libraries. Instrument development, which does require significant institutional support, can be done in collaboration with local facilities such as those at Lockheed Martin Corporation and Ball Aerospace and Technologies Corporation.

2011 Research Highlights

Studying the Galactic Neighborhood

We are inhabitants of a large spiral galaxy, with our solar system "neighborhood" being about ½ the distance between the center and edge. Our Galaxy is flat like a pancake, with a height-to-width ratio similar to that of a hardback book cover. However, at the center of the Galaxy is a supermassive black hole whose continuing growth is fueled by infalling stars and gas. The figure on page 9 (top) illustrates what our galaxy might look like as viewed from the "top".





SSI Senior Scientists Barbara Whitney (Madison, WI office) and Mike Wolff (Brookfield, WI office) were Co-Investigators on the "GLIMPSE" team that surveyed the Galaxy at infrared wavelengths using the Spitzer Space Telescope (SST), which was launched in 2003 and remains operational (in part) today. This set of observations allowed us to see stars with unprecedented sensitivity and resolution at all stages of their lifecycles throughout our Galaxy. The acronym GLIMPSE – Galactic Legacy Infrared Midplane Survey Extraordinaire – is meaningful not just in the words that it represents, but also in that it captures the sense of taking a "glimpse" at the Galaxy. The observational program obtained many short exposures in order to observe as much area as possible within a reasonable amount of "telescope time." The initial surveys (GLIMPSE and GLIMPSE II) observed our Galactic plane from the Galactic center out to 65 degrees in longitude on both sides, and with a width of 2 degrees in latitude. The spectacular nature of these original campaigns can be seen in the figure on the left, which shows a combination of GLIMPSE and GLIMPSE II in one view. Several follow-up surveys sampled higher latitudes (GLIMPSE3D) and extended the plane coverage to all 360 degrees of longitude (GLIMPSE360). The currently active Deep GLIMPSE project is revisiting the inner Galaxy, but with the goal of a seeing farther or deeper than the earlier observations. Although she began as a Co-Investigator, Whitney became the Principle Investigator for both GLIMPSE360 and Deep GLIMPSE.

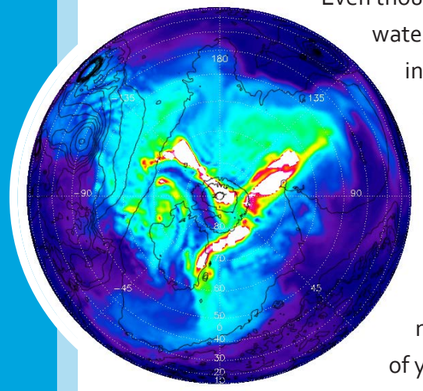
Water Vapor and Climate on Earth

Water vapor in Earth's upper troposphere plays a crucial role in regulating climate. At altitudes of 30,000 to 45,000 feet, well above most "weather," water vapor acts as a greenhouse gas whose presence can warm the atmosphere. Because the amount of water present is controlled most strongly by temperature, atmospheric warming driven by factors such as an increase in carbon dioxide will increase the amount of water that can be held in the air. This type of feedback mechanism will further warm the planet, amplifying the initial warming trends. The specific details of this effect are complicated by many factors including the current limitations in the database of upper tropospheric water vapor measurements. A typical satellite mission can provide global water vapor measurements for a period of 6-8 years. While this allows scientists to study the year-to-year variations associated with what one typically calls weather, it severely limits one's capability to characterize the long-term variations that are associated with climate. The situation is exacerbated by the fact that there can be multi-year gaps between the satellites that make such measurements. As a result, the ability to connect these satellite datasets into a continuous record is an area of active research by atmospheric scientists.

Left Page Top :: Artist's conception of our Galaxy, based upon an analysis of currently available data. Credit: R. Hurt, NASA-JPL/Caltech
Left Page Bottom :: Poster version of the GLIMPSE and GLIMPSE II survey strip. A full resolution version of this survey is on display at the Adler Planetarium in Chicago where it spans a width of 3 ft and length of 180 feet! A zoomable version has been created by SSI staff J. Harold and E. Vidugiris (www.alienearths.org/glimpse). Credit: NASA
Right Page :: An example of the type of weather balloon that is used to study water vapor in the Earth's upper atmosphere. Credit: NASA/JPL

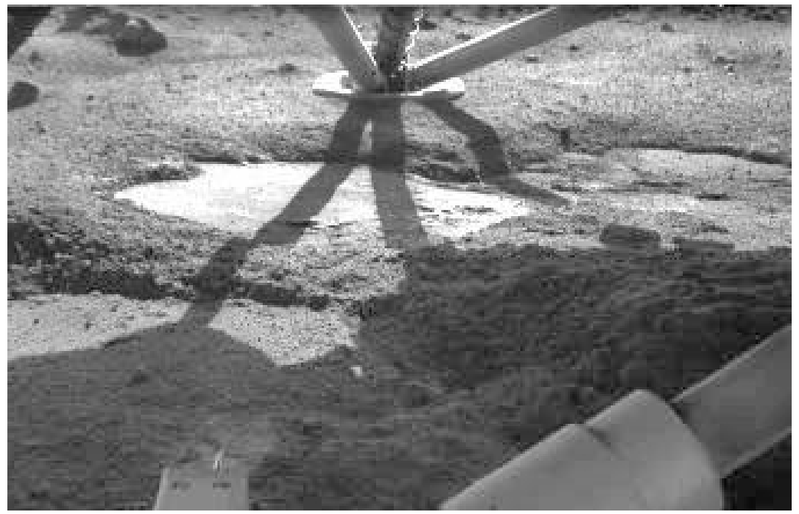
SSI Senior Research Scientist Brad Sandor (Boulder, CO office) studies the behavior of upper tropospheric water, primarily through the data provided by two NASA satellites instruments, which contain a "gap" in their observational coverage of the type mentioned previously: the Upper Atmospheric Research Satellite (UARS, operated 1991-1997) and the Aura satellite (operating 2004-present). As a result, his work has involved efforts to connect or "cross-calibrate" the two separate datasets. To do this, he uses measurements of upper tropospheric water from balloon-bourne instruments. These balloons are launched from a small number of meteorological stations providing consistent long-term data, but only for a few geographic locations. By comparing UARS measurements with balloon data obtained at the same time and place, and similarly comparing Aura observations with coincident balloon data, Sandor is working to establish calibration between UARS and Aura. The end-result will be an improved understanding of the two datasets and the ability to better examine long-term variations in water vapor and its connections to the Earth's climate.

Simulating water vapor transport in the Martian Arctic



Even though Mars is drier than Earth's most arid deserts, there is a lot of water on Mars – but it's mostly to be found frozen in the polar caps and in the soil. Every summer some ice evaporates from the polar caps and from the soil and is redistributed across the planet by winds. Every winter some water vapor from the atmosphere freezes back onto the polar caps and into the soil. The cycle repeats every year. It is not known if this cycle is balanced or if the polar caps and soil are slowly losing or gaining the ice. If the cycle is not balanced, Mars, not unlike Earth, may experience 'ice ages' with massive ice sheets periodically growing and receding over millions of years. To understand this climate change on Mars, the exchange of water between all of the reservoirs on the planet – the ice caps, the soil and the atmosphere – needs to be better understood. The recent discovery of very pure ice in the Martian soil (see figure on page 12) adds an intriguing twist to the problem of water transport on Mars. The soil ice that forms from diffusion of vapor from the atmosphere is expected to be dirty; hence pure ice raises the possibility of liquid water existing on Mars today or in the not too distant past.

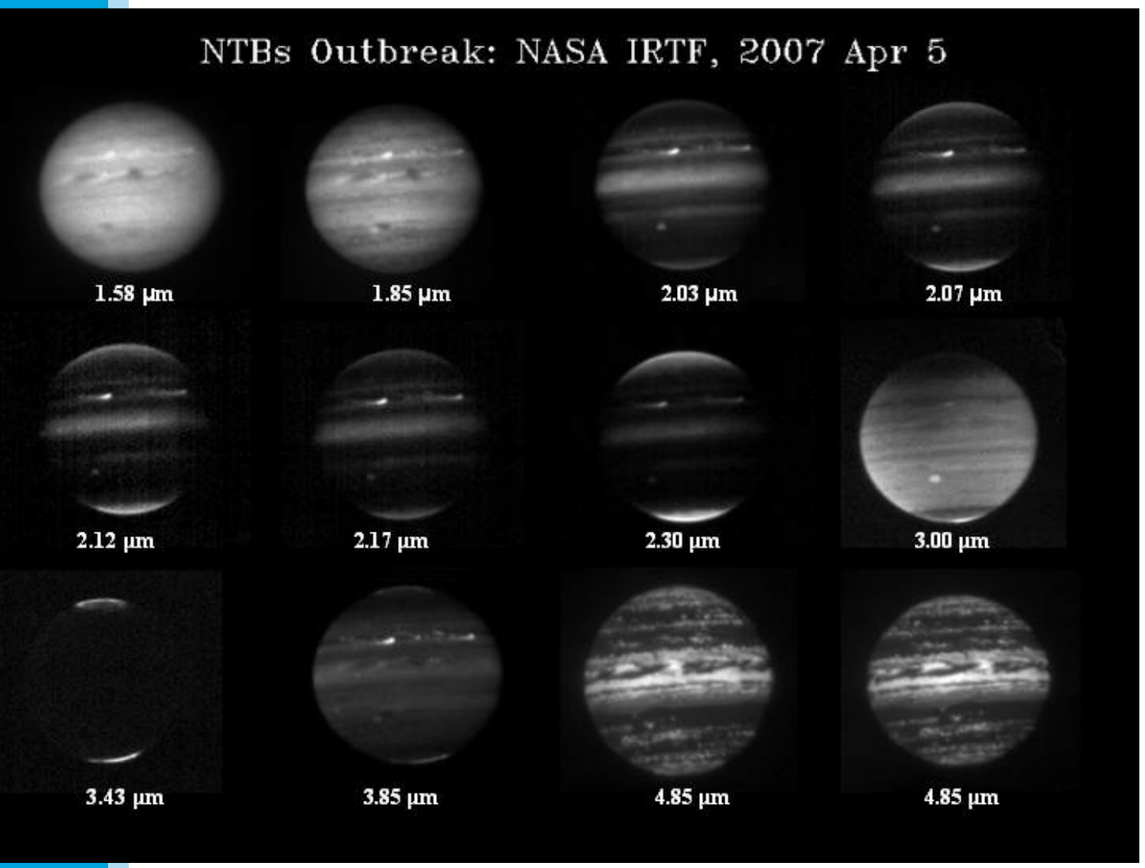
SSI Research Scientist Alexey Pankine (Arcadia, CA office) uses supercomputers at the Jet Propulsion Laboratory in Pasadena, CA to simulate the atmospheric transport of water vapor coming from the northern polar cap during Martian summer. These computer models demonstrate that the vapor does not simply move southward in all directions, but actually moves in three specific directions. As seen in the figure on page 11, the water vapor tends to follow surface contours until it encounters obstacles like plateaus and hills, at which point it changes its course. In addition, it can also form vortices and plumes that drift across the polar region.



Left Page :: Simulated distribution of water vapor in the Martian polar atmosphere. The winds carry the vapor away from the north polar region in three distinct directions. Contrary to the situation on Mars, we find most of the water vapor in the equatorial regions on Earth. Credit: A. Pankine (SSI), A. Toigo (Cornell)

Right Page :: The Phoenix Lander descent rockets blew away several inches of Martian soil exposing patches of pure water ice beneath the spacecraft. Credit: NASA

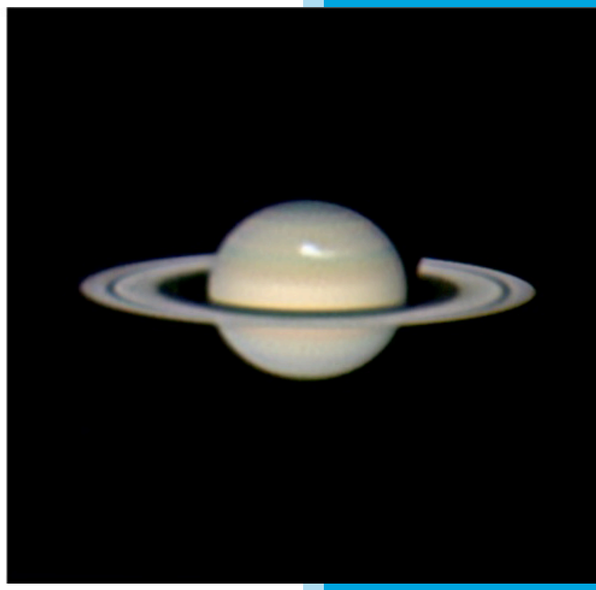
Stormy Weather on Jupiter and Saturn: Need for Ground-based Observations



Above :: An example of disturbances associated with a "global upheaval" on Jupiter, observed in 2007 in near-infrared wavelengths. Credit: NASA/IRF

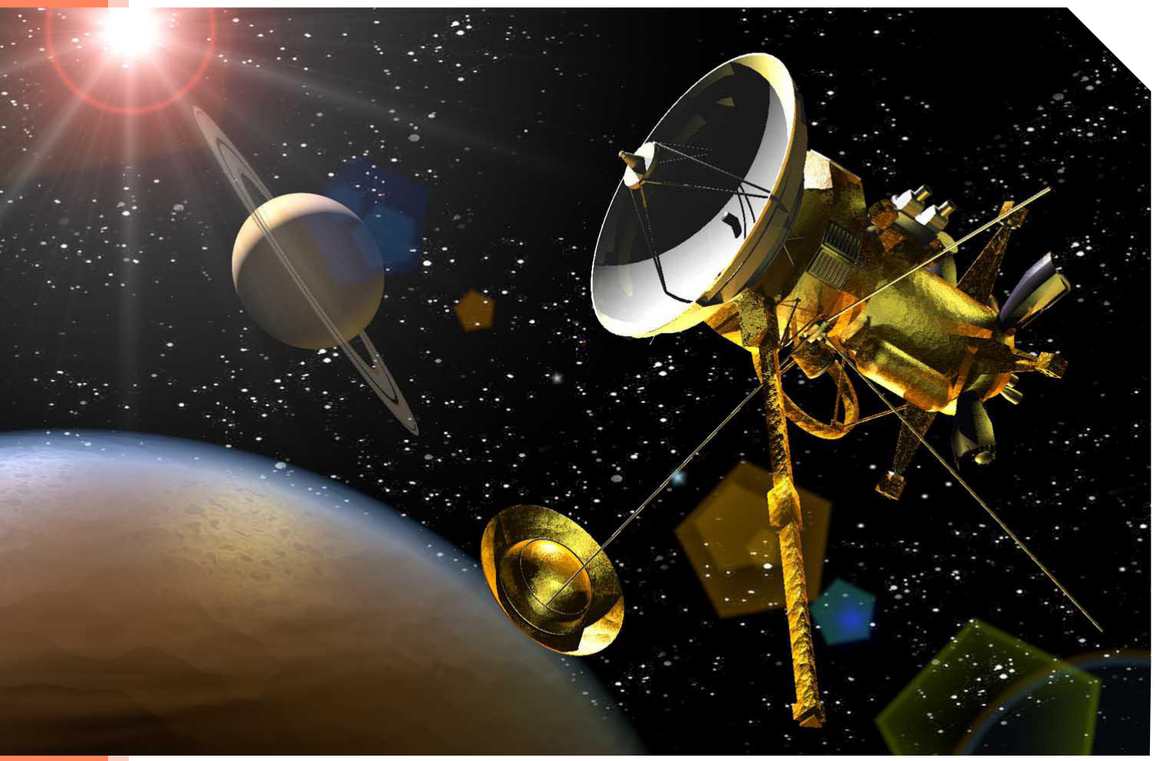
Page 14 :: Outbreak of the Great White Storm as captured by amateur astronomer. Credit: A. Wesley

The obliquity or tilt of a planet's axis is a driver of seasons, which can lead to changes in global temperatures and weather patterns. In this way, Jupiter and Saturn demonstrate atmospheric states that both excite and challenge observers and modelers, while testing previous theories. Through partnerships between professional and amateur astronomers, the combination of ground-based and spacecraft observations is providing important insight into these phenomena and is assisting scientists with the development of new predictive models. Even with the presence of current and future NASA missions (e.g., Cassini, Juno), similar advances will require the type of regular monitoring of Jupiter's and Saturn's atmospheres offered by the inclusion of ground-based observations.



SSI Senior Researcher Padma Yanamandra-Fisher (Rancho Cucamonga, CA office) studies the atmospheres of both planets by employing this important synthesis of ground-based and spacecraft observations. For example, Jupiter undergoes an intriguing, dramatic "global upheaval" that occurs approximately every 15 years, and can last several years. During this event, one can see major changes in cloud properties and temperatures at all latitudes on the planet (See figure on page 13). Similar dynamic events can occur with Saturn as well. It's usually bland appearance underwent unexpected, rapid changes with the outbreak of the Great White Storm in December 2010; an event that continues today (see figure on the right). Padma's ongoing efforts include analyses of such observations to better understand the factors and consequences associated with such large atmospheric changes.

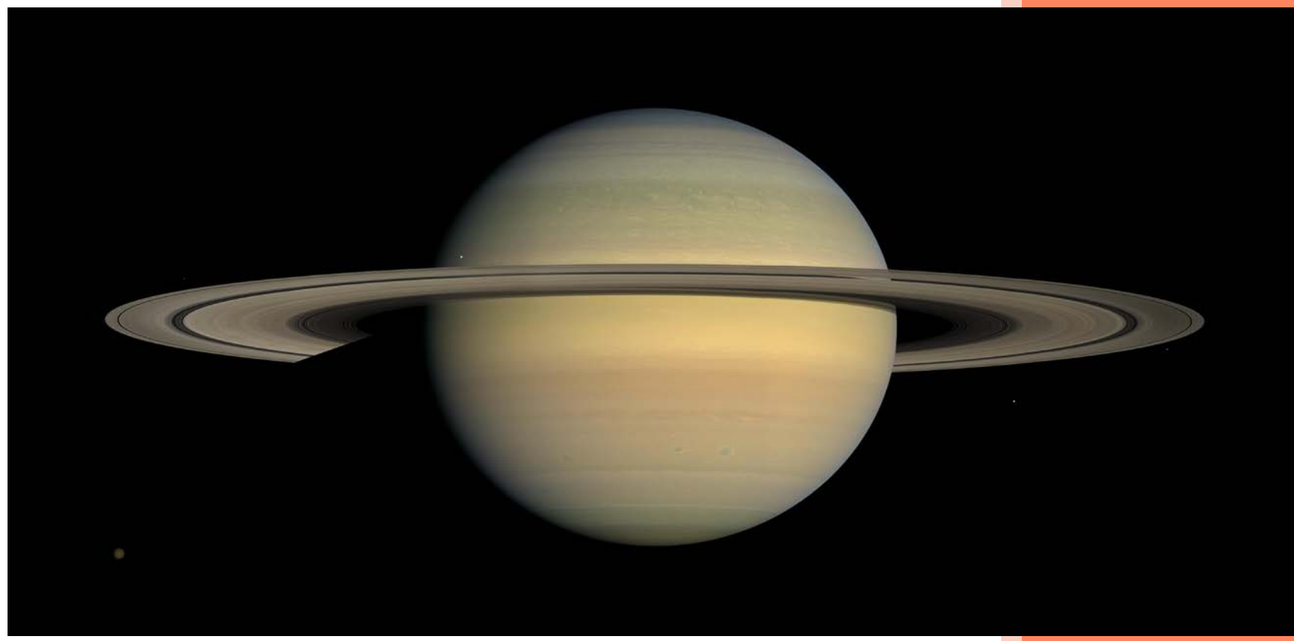
FLIGHT OPERATIONS



The Cassini Imaging Central Laboratory for Operations (CICLOPS) is located at SSI's Headquarters Office in Boulder, CO. CICLOPS is the center for uplink and downlink operations for the imaging science experiment on the Cassini mission to Saturn. All images produced by the two powerful telescopic cameras onboard Cassini (the Imaging Science Subsystem) make their way across more than a billion and a half kilometers (1 billion miles) of space to be archived in databases at CICLOPS and made available to imaging team members across the globe, researchers, and the public.

The Cassini-Huygens mission continues to change our view of the Saturn system. Since arriving at Saturn in the summer of 2004, the intrepid spacecraft has completed numerous close flybys of Saturn's moons, providing new perspectives and a wealth of data about this unique collection of objects. Cassini has monitored powerful lightning-generated radio outbursts and cloud activity produced by giant storms on Saturn that dwarf those on Earth. The Huygens probe landing on haze-shrouded Titan and Cassini's continuing survey of this moon from space have provided tantalizing glimpses of a world that is at once remarkably earth-like yet also frigid and alien. The startling revelation that Saturn's small, icy moon Enceladus may possess underground reservoirs of liquid water has widened our perception of the range of environments that might be hospitable for life.

Images taken by Cassini are selected for release to the public at CICLOPS. Chosen images and movie sequences are processed to ensure quality, including the best possible color. The final products are posted to the CICLOPS website (http://ciclops.org) for distribution to the waiting world.



Left Page Top :: An artist rendering of Saturn, Titan, and the Cassini spacecraft. Credit: NASA
Other images in this section :: Credit: NASA/JPL/SSI

Also posted on the CICLOPS site are imaging news stories, upcoming mission events, public discussions, Saturn-inspired artwork, and more.

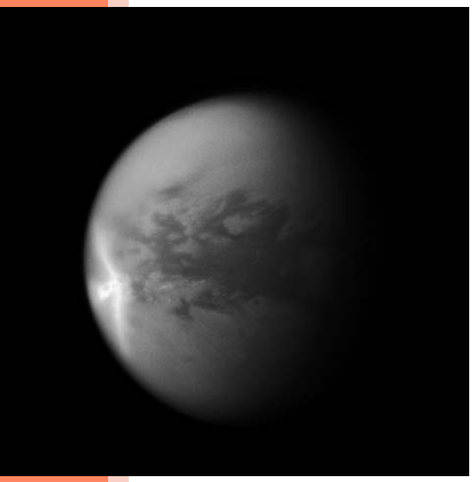
Cassini's landmark exploration of the ringed planet, its mysterious moons, stunning rings, and complex magnetic environment will continue through 2017 when the spacecraft's third and final mission will come to an end. CICLOPS team members and the Cassini mission scientists and engineers are now hard at work executing the seven-year Cassini Solstice Mission.

The Cassini-Huygens mission is a cooperative project of NASA, the European Space Agency, and the Italian Space Agency. The Jet Propulsion Laboratory, a division of the California Institute of Technology in Pasadena, manages the Cassini-Huygens mission for NASA's Science Mission Directorate, Washington, D.C.

Cassini/Saturn Research

Fourteen scientists from the United States and Europe comprise the CICLOPS team (led by Senior Research Carolyn Porco, Boulder, CO office) that uses Cassini's cameras to investigate many unique features of the Saturn system. The Imaging Team continues to publish findings from their investigations, deepening our knowledge about Saturn and the processes by which planets—and whole planetary systems—form and develop with time.

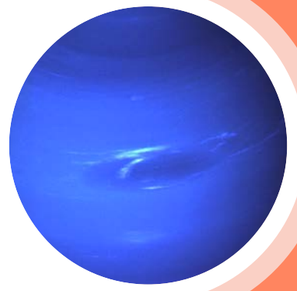
In 2011, Cassini images graced the pages of scores of magazines and websites around the globe. The mission continues to generate exciting science and exquisite imagery from the Saturn frontier.



2011 Cassini Highlights

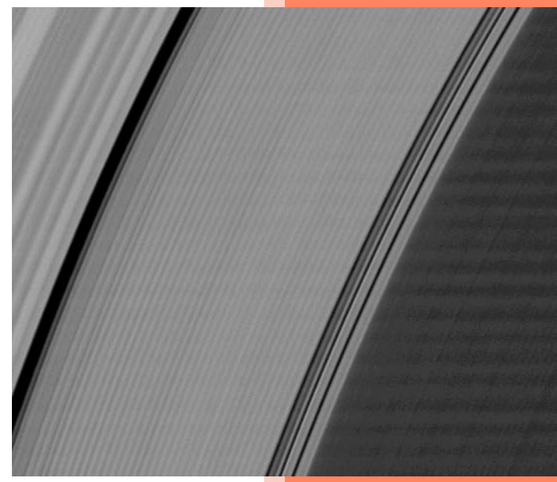
Methane Rain on Titan's Deserts

Images from Cassini provided the first evidence of methane rain soaking Titan's equatorial deserts. An arrow-shaped storm appeared in the equatorial regions of Saturn's largest moon on Sept. 27, 2010 – the equivalent of early April in Titan's "year." A broad band of clouds appeared the next month. Cassini's imaging science subsystem captured short-lived surface changes visible in images of Titan's surface. A 193,000-square-mile (500,000-square-kilometer) region along the southern boundary of Titan's Belet dune field, as well as smaller areas nearby, had become darker. Scientists concluded this change in brightness is most likely the result of surface wetting by methane rain. These observations suggest that recent weather on Titan is similar to that over Earth's tropics.



Forensic Sleuthing Ties Ring Ripples To Impacts

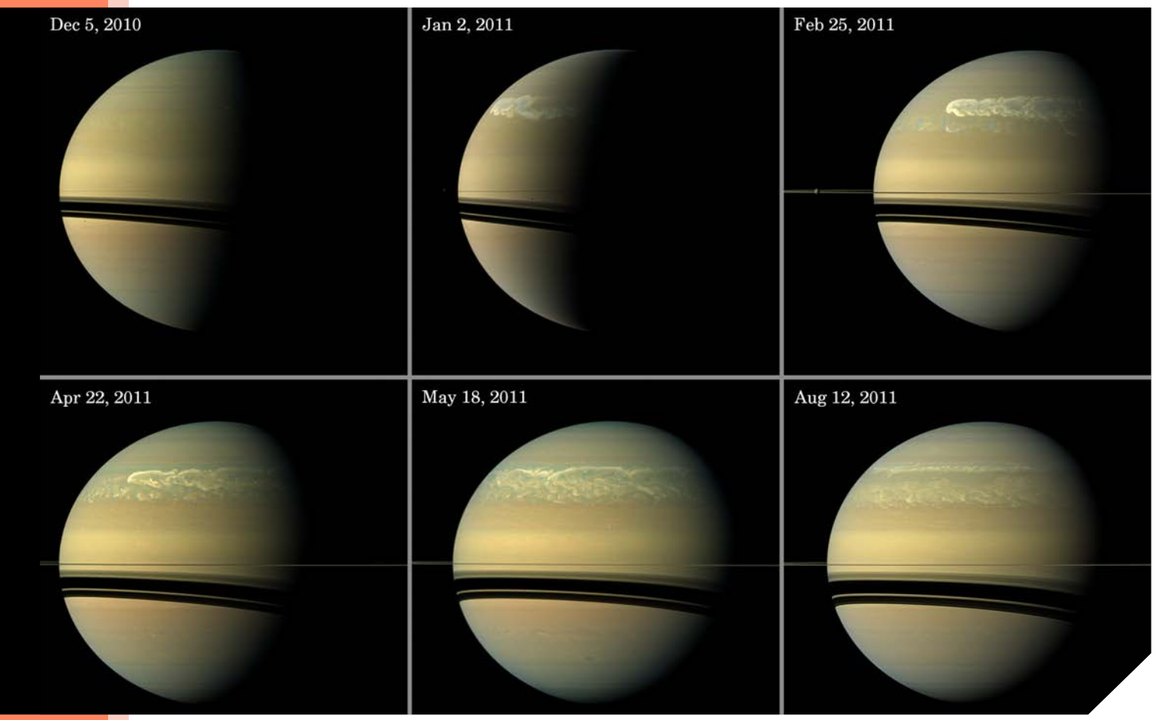
Scientists analyzed Cassini data to trace telltale ripples in Saturn's rings to a cloud of comet debris that likely plunged through the inner rings in late 1983. The researchers found that the grooves in Saturn's D ring, reported earlier in the Cassini mission, appeared to wind together more tightly over time. Playing the process backward, an imaging team scientist demonstrated the pattern originated when something tilted the D ring off its axis by about 100 meters (300 feet). Scientists found the influence of Saturn's gravity on the tilted area warped the ring into a tightening spiral. The collision had tilted a region more than 12,000 miles (19,000 kilometers) wide, covering part of the D ring and the next outermost ring, called the C ring. Scientists also used this process to conclude that the debris cloud of comet Shoemaker-Levy 9 created similar ripples as it hurtled through the thin Jupiter ring system in July 1994.



Left Page :: A huge arrow-shaped storm blows across the equatorial region of Titan, chronicling the seasonal weather changes on Saturn's largest moon.
Right Page :: The corrugated appearance of a spiral wave propagating through Saturn's rings appears as light and dark lines in the middle of this view from Cassini.

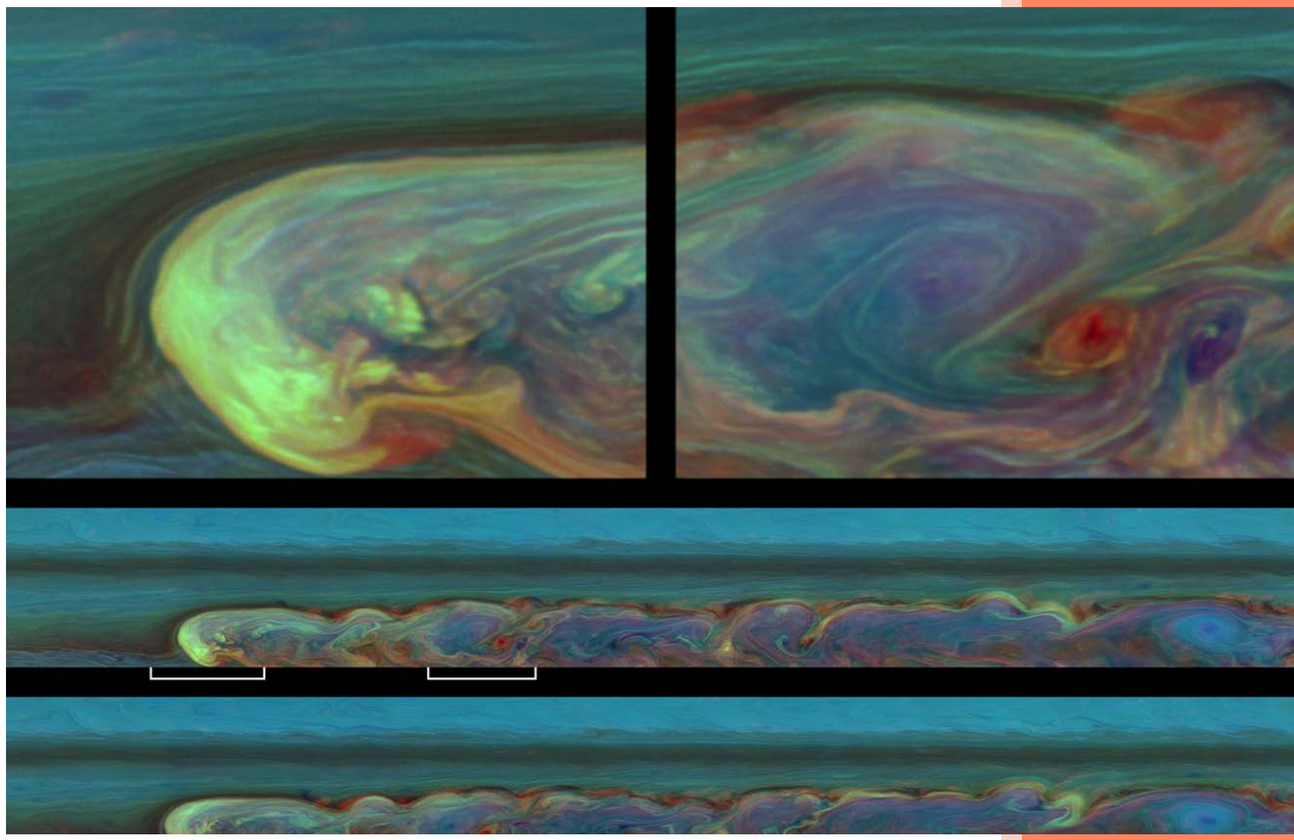
Chronicling Saturn's Huge Northern Storm

Since December 2010, the imaging team has tracked a huge storm churning in Saturn's northern hemisphere. Other instruments on Cassini detected the storm's electrical activity and revealed it to be a convective thunderstorm. Its active convecting phase ended in late June 2011, but the turbulent clouds it created continue to linger in the atmosphere as of December 2011. The storm's 200-day active period makes it the longest-lasting planet-encircling storm ever seen on Saturn.



Above :: This series of images shows the development of the largest storm seen on the planet since 1990. These true color and near-true-color views chronicle the storm from its start in late 2010 through mid-2011, showing how the distinct head of the storm quickly grew large but eventually became engulfed by the storm's tail.

Cassini has taken hundreds of images of this storm as part of the imaging team's "Saturn Storm Watch" campaign. These images, together with other high quality images collected by Cassini since 2004, allow scientists to trace the subtle changes on the planet that preceded the storm's formation and have revealed insights into the storm's development, its wind speeds, and the altitudes at which its changes occur.



Above :: These false-color images chronicle a day in the life of Saturn's huge northern storm. The two long mosaics on the bottom were taken about 11 hours, or one Saturn day, apart. The different colors show clouds at varying altitudes.

NATIONAL CENTER FOR INTERACTIVE LEARNING

*The **National Center for Interactive Learning** (NCIL) is dedicated to expanding the understanding and participation of families, youth, educators, and citizens in science and technology through learning research and innovative programs.*

The Space Science Institute (SSI) launched NCIL, in May 2010, to expand its strong educational efforts. Dr. Paul Dusenbery is the Executive Director of SSI and the Director of NCIL. Visit www.nc4il.org for more information. NCIL is organized around five interconnected groups:

1. **Exhibition Development**
2. **Digital Learning**
3. **Professional Development**
4. **Community Outreach**
5. **Learning Research and Evaluation.**

NCIL programs span a range of audience needs and delivery methods. These include traveling museum exhibitions; digital learning technologies (e.g. gaming, augmented and mixed reality, novel data visualization systems, and online learning); hands-on teaching resources and activities; educator workshops; outreach to underserved audiences, such as girls' groups, Hispanic, Native American, urban and rural communities; and successful partnership building between scientists and educators. NCIL conducts external evaluations for a number of informal education organizations as well as providing internal evaluation services for on-going projects.

Educational projects include large-scale, institutional-level efforts supported by NSF and NASA (e.g., *Great Balls of Fire*, *Space Weather Outreach*, and STAR_Net) as well as smaller-scale projects that focus on individual scientists seeking educational support for research

projects (e.g., an asteroids project funded by NSF called *Finding NEO*). This strategic approach allows NCIL to leverage the needs and effectiveness of both kinds of endeavors and to explore new educational methods and effectively "scale up" those that show promise.

In keeping with that strategy, NCIL is pursuing new directions for educational programming: a strategic partnership with the American Library Association to pilot interactive STEM exhibits in libraries in Colorado and beyond (e.g. *Discover Space*, *Discover Earth*, and *Discover Tech*); applications of internet technologies to facilitate social learning experiences (e.g. *Making Space Social*); and the continued development of educational multimedia capabilities. NCIL staff and their partners are leading the way to a new generation of educational innovation, which bridges the worlds of STEM research, education, and communication.

Guiding Principles

- Excite learners of all ages, ethnicities, and learning modalities with the thrill of scientific discovery.
- Integrate STEM research and STEM education.
- Ensure scientific accuracy in all activities.
- Rigorously evaluate and disseminate results.
- Cultivate mutually beneficial partnerships in STEM and education communities.
- Contribute significantly to educational research.

NCIL Impacts for 2011

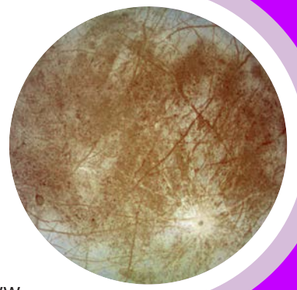
- 275,000 visitors to museum exhibits
- 95,000 visitors to library exhibits
- 550,000 visits to NCIL educational websites
- 125 participants in educator workshops, virtual workshops, and conference presentations
- 25,000 downloads of NCIL educational materials, activities, and resources distributed online

2011 Highlights

Great Balls of Fire: Asteroids, Comets, and Meteors

The National Science Foundation (NSF) funded the development of the *Great Balls of Fire* exhibition (PI Paul Dusenbery, Boulder, CO office), with additional support from the NSF and NASA funded *Finding NEO* project (PI James Harold, Boulder, CO office). Project partners include NASA's WISE and Dawn Missions, Catawba Science Center, New Mexico Museum of Natural History and Science, the Astronomical Society of the Pacific (ASP), the Association of Science-Technology Center (ASTC), and Institute for Learning Innovation (ILI).

The centerpiece of the informal education project is a 3,000-square foot traveling exhibit. To date, the exhibit has been on display at the Science Museum of Virginia and the Strategic Air and Space Museum (in Ashland, NE). There is also a 750 square foot version of the exhibit, which is currently at the Tyler Junior College Planetarium (in Tyler, TX) and the Columbia Memorial Space Center (in Downey, CA). NCIL developed an Education/Outreach program with ASP and Catawba Science Center for museum educators, docents, and amateur astronomers. This includes the *Space Rocks Toolkit* which has been distributed to amateur astronomy clubs across the country. A Professional Development Program is also in place for science center staff and other informal education professionals (led by ASTC). The project's public website (www.GreatBallsOfFireExhibit.org) provides information about the exhibit and includes exhibit activities and images.

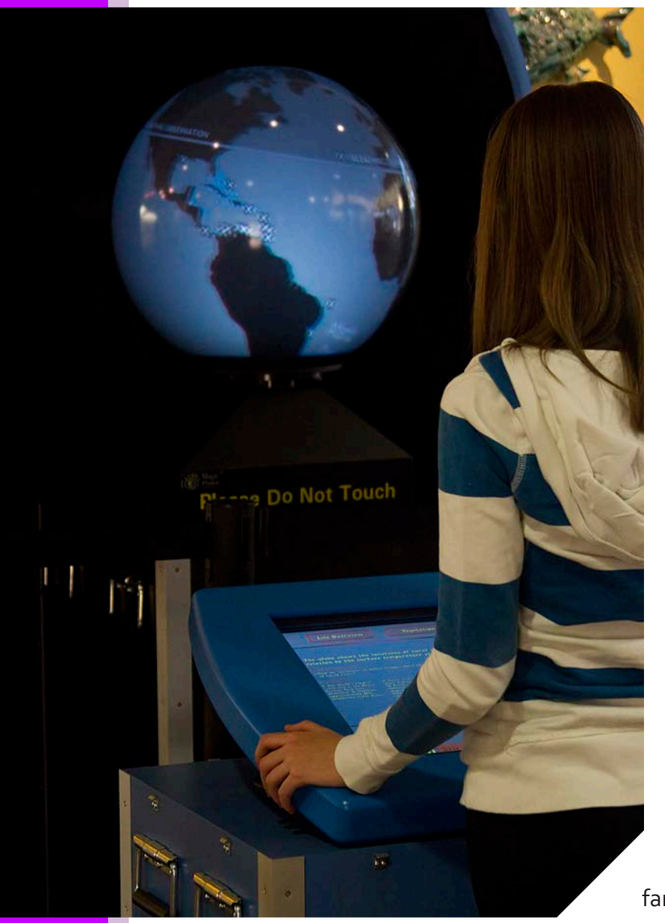


Three teams of middle school students from North Carolina, New Mexico, and Colorado assisted with the development process, and each team created an exhibit or multimedia piece for their communities. The ILI is conducting all phases of the project's evaluation, including a research project about the use of Web 2.0 in the development process.

Finding NEO was funded through an education grant from NASA and a "Communicating Research to Public Audiences" supplement from NSF. The project has produced an interactive website on asteroids and comets (www.KillerAsteroids.org) as well as a small exhibit. Both are designed to communicate the fundamentals about asteroids and comets, as well as how researchers, aided by amateur astronomers, learn about these objects. The exhibit opened at the Fiske Planetarium in Boulder, Colorado, and is now at the Lafayette Public Library in Lafayette, Colorado. The project evaluation will compare visitor interactions at both venues.

Left Page :: A panoramic view of the Great Balls of Fire exhibit while in Richmond, VA. Credit: NCIL/SSI
Right Page :: Young visitors at the Great Balls of Fire exhibit explore one of its interactives. Credit: NCIL/SSI

Science and Technology Exhibits Transform Libraries



With more than 16,000 locations, public libraries serve almost every community in the country. Nationwide, they receive about 1.5 billion visits a year, and they offer their services for free. Because libraries are often within walking distance of at least half of their patrons or near public transportation lines, they can circumvent two barriers—cost and transportation—that prevent a lot of people from visiting science museums. While museums work to attract teenage audiences, teenagers are regular users of library services. In addition, many libraries are already providing innovative STEM activities in their youth programs. For these reasons, libraries can be ideal venues for reaching new and underserved audiences with a variety of STEM programming, including interactive exhibits.

The essential mission of most public libraries is to serve their communities with lifelong learning opportunities. With thousands of libraries, there is an enormous potential for engaging underserved youth and their families in fostering an appreciation and deeper understanding of science and technology topics. To utilize this largely untapped resource, NCIL, in partnership with the American Library Association (ALA), the Lunar and Planetary Institute, and the National Girls Collaborative Project, has received funding from the National Science Foundation (NSF) to create a new national education project for libraries that focuses on building STEM skills through developing Science-Technology Activities and Resources (STAR). This project, known as the *STAR Library Education Network* (STAR_Net), is a hands-on learning program for libraries and their communities across the country (PI Paul Dusenbery, Boulder, CO office).

The project is developing two interactive traveling exhibits (*Discover Earth: A Century of Change* and *Discover Tech: Engineers Make a World of Difference*), coupled with a variety of education and outreach programs. This additional programming includes hands-on activities related to the content of the exhibits for different age groups. STAR_Net also provides library staff with training (online and in-person) that introduces them to the STEM content of the exhibits, guides them in developing complementary programming, and helps them implement the STAR_Net activities. The reach of the STAR_Net project goes beyond the host libraries though. STAR_Net has created an online community of practice that includes host and non-host librarians and STEM professionals. Members of the STAR_Net community of practice can meet online, share resources, and develop their own activities. In 2011, the project team focused on developing *Discover Earth*, an exhibit concentrating on earth systems science. It includes a Magic Planet Globe, where patrons can explore various NASA and NOAA datasets, including hurricanes, tsunamis, and plate tectonics; as well as a touch table where patrons can learn more about ecosystems and the arctic, and test their ability to correctly label different types of ecosystems. The *Discover Earth* exhibit debuted at the Louisville Public Library in Colorado in late 2011 and will begin its national tour in 2012 to ten libraries.

Left Page :: A patron at the Louisville Public Library explores an interactive in the Discover Earth exhibit. Credit: NCIL/SSI
Right Page :: Three patrons play an ecosystem game on a 42" touch table at the TLL Temple Memorial Library, Diboll, TX. Credit: Brenda Russell
Page 21 :: Credit: NCIL/SSI

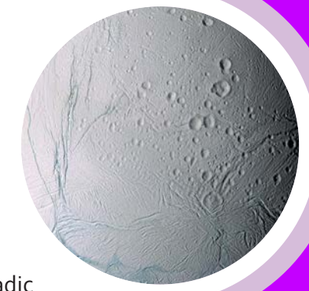
Bill Nye's Climate Lab

At the 2011 Association of Science-Technology Centers (ASTC) annual meeting, The Chabot Space & Science Center's exhibition Bill Nye's Climate Lab (BNCL) recognizes exhibitions that significantly advance the mission of all science centers. Opened in late 2010, BNCL is a 4,100 square foot permanent exhibition designed to increase climate science literacy and engagement in youth ages 8-14. A central element of the project is to extend the cycle of engagement with the visitors' experience with the content, using conservation challenges visitors encounter within the exhibit and then extending those challenges online. Visitors will not only engage in conservation challenges online, but also return to the exhibit to reengage at Chabot, and finally pursue conservation-related behaviors within their daily lives. Chabot also maintains a website for the exhibition at www.BillsClimateLab.org. The site continues the visitor experience at home or in the classroom and was nominated for two Webby Awards.

In 2011 the Gordon and Betty Moore Foundation gave Chabot a grant to expand and enhance the exhibition. Kate Haley Goldman, NCIL's Director of Learning Research and Evaluation (Silver Spring, MD office), is leading remedial, formative, and summative evaluation for BNCL. Currently, NCIL's work is to evaluate connections between the visitors' experience within the exhibit, on the website afterwards, within their community as they complete climate challenges, and then hopefully as they return to Chabot. This study is important, as it focuses on the extension of the visitors' exhibition experience into the other facets of their lives. Chabot has found the climate challenges to be highly motivating for visitors within the exhibition, and now the team aims to extend that experience through at-home participation. Incorporating game-based rewards systems within these challenges and achieving the appropriate balance of such activities requires extensive visitor feedback.

Above :: Visitors explore an interactive in Bill Nye's Climate Lab. Credit: Chabot Space and Science Center

Building Worlds And Learning Astronomy On Facebook



With support from NSF and NASA, Dr. James Harold (PI, Boulder, CO office), Dr. Dean Hines, and a team at NCIL are developing an end-to-end stellar and planetary evolution game for the Facebook platform. The last few years have seen an explosion of popularity in social, "sporadic play" games such as Farmville, Mafia Wars, and MouseHunt, where players may only take actions a few times a day, but continue playing for months. This framework is an excellent fit for teaching about the evolution of stars and planets. Players will select regions of the galaxy to build their stars and planets, and watch as the systems evolve in scaled real time (a million years to the minute). Massive stars will supernova within minutes, while lower mass stars like our sun will live for weeks, possibly evolving life before passing through a red giant stage and ending their lives as white dwarfs. Successful systems will advance players, allowing them to create different types of stars and planets, seed life, and customize their worlds.

The project provides the opportunity to introduce a wide variety of key astronomy topics to a large and demographically diverse group. As players advance in the game they will explore concepts including stellar lifecycles, habitable zones, and the roles of giant worlds in creating habitable solar systems. Meanwhile the research and evaluation program will examine both the effectiveness of this game as a learning tool, as well as the broader potential of this class of game for the educational community.

Above :: A schematic of a double star forming region. Credit: NASA

FINANCIAL REPORT

Space Science Institute
Summary Statement of Financial Position
as of December 31, 2011 and 2010

	2011	2010
Assets		
Assets		
Cash and cash equivalents	$ 752,854	$ 558,700
Accounts receivable	992,081	754,740
Prepaid expenses and deposits	77,543	68,985
Net furniture, equipment, and property	35,430	55,253
Total assets	$ 1,857,908	$ 1,437,678
Liabilities and Net Assets		
Liabilities		
Accounts payable and accrued liabilities	$ 448,731	$ 345,570
Deferred revenues	692,388	544,637
Line of credit	365,000	231,580
Total liabilities	1,506,119	1,121,787
Net assets		
Unrestricted	246,462	256,244
Temporarily restricted	105,327	59,647
Total net assets	351,789	315,891
Total liabilities and net assets	$ 1,857,908	$ 1,437,678

Summary Statement of Activities
for the years ended December 31, 2011 and 2010

	2011	2010
Support and revenue		
Grants, contracts, and cooperative agreements	$ 5,907,841	$ 5,201,714
Contributions	4,950	1,350
Exhibit income	135,000	86,885
Interest income	364	446
Loss on disposal of equipment	-	(13,787)
Other income	2,265	339
Total support and revenue	6,050,420	5,276,947
Expenses		
Program services	5,985,358	5,223,579
General and administrative	29,164	20,904
Total expenses	6,014,522	5,244,483
Change in net assets	35,898	32,464
Net assets, beginning of year	315,891	283,427
Net assets, end of year	$ 351,789	$ 315,891

The summary financial information does not include sufficient detail or disclosures to constitute presentation in conformity with accounting principles generally accepted in the United States of America. If the omitted detail or disclosures were included, they might influence the user's conclusions about the Organization's financial position, changes in net assets, and cash flows. Accordingly such information should be read in conjunction with the Organization's audited financial statements for the years ended December 31, 2011 and 2010, from which the summarized information was derived. A copy is available upon request.

WWW.SPACESCIENCE.ORG

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