National Aeronautics and Space Administration

NASA Earth and Space Science Explorers

Include people of all ages and backgrounds who embody the spirit of discovery, and who use NASA science and technology to explore from planet Earth to the far reaches of the universe.

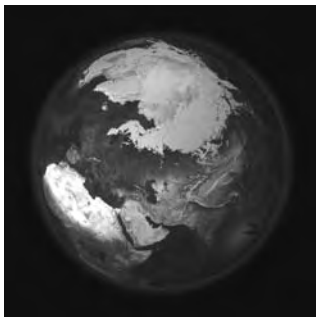
Learn more about these explorers at:

Earth Explorers
http://science.hq.nasa.gov/education/earth_explorers

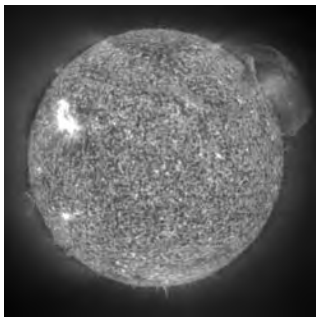
Space Science Explorers
http://science.hq.nasa.gov/education/space_explorers

www.nasa.gov

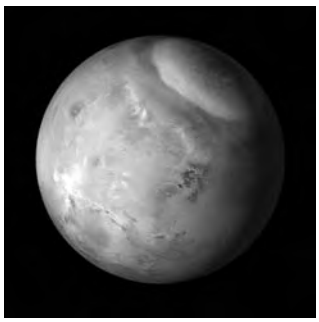
earth and space science explorers



Earth



Sun



Mars

Hubble Galaxy Cluster

About the Satellite Images on the Front

The satellite images shown on the front of this poster are all taken from separate NASA instruments and show the sun, Earth, Mars and other galaxies. They are not to scale. If the size and distance were accurate, the image of Earth would be a tiny dot next to the image of the sun. Mars and the other galaxies would be invisible.

EARTH This image of Earth highlights the Arctic region on April 23, 2003, with sea ice brightness temperature data from the AMSR-E instrument shown in light blue and snow cover data from the MODIS instrument shown in white.
Credit: NASA/Goddard Space Flight Center Scientific Visualization Studio
http://svs.gsfc.nasa.gov/vis/a000000/a003100/a003181

SUN The Solar and Heliospheric Observatory (SOHO) obtained this image of the sun on August 26, 1997. A huge prominence—an eruption of gas in the solar atmosphere—can be seen near the top right of the image. The material in the prominence is at temperatures of 60,000–80,000 K, much cooler than the surrounding corona, which is typically at temperatures above 1 million K. The prominence is over 350,000 km (216,000 miles) across, large enough to span 28 Earths.
Credit: The SOHO-EIT Consortium
http://sohowww.nascom.nasa.gov/gallery/SolarCorona/eit023.html

HUBBLE GALAXY CLUSTER The background photo used on the poster front is made from images taken by NASA's Hubble Space Telescope in January 2005 and February 2006. It shows the diverse collection of galaxies in a galaxy cluster called Abell S0740, located more than 450 million light-years away in the constellation Centaurus.

The giant elliptical ESO 325-G004 looms large at the cluster's center (visible here, but not on the poster front). The galaxy is as massive as 100 billion of our suns. Globular clusters—compact groups of hundreds of thousands of stars that are gravitationally bound together—can be seen as pinpoints of light contained within the galaxy's diffuse halo.

Other fuzzy elliptical galaxies dot the image. Some have evidence of a disk or ring structure that gives them a bow-tie shape. Several spiral galaxies are also present. The starlight in these galaxies is mainly contained in a central bulge and follows along spiral arms in a disk.
Credit: NASA, ESA, and The Hubble Heritage Team (STScI/AURA)
http://hubblesite.org/newscenter/archive/releases/2007/08/image/a

MARS Vast canyons, towering volcanoes, sprawling fields of ice, deep craters, and high clouds can all be seen in this image of the fourth planet from the sun: Mars. The Mars Global Surveyor spacecraft took this mosaic of images as springtime dawned in northern Mars in May 2002. Sprawled across the image bottom is Valles Marinaris, a canyon over five times the length and depth of Earth's Grand Canyon. On the left are several volcanoes including Olympus Mons, a volcano three times higher than Earth's Mt. Everest. At the top is the North Polar Cap made of thawing water and carbon dioxide-based ice. Swirling white clouds and circular impact craters are also visible.
Credit: Malin Space Science Systems (MSSS), Jet Propulsion Laboratory (JPL), and NASA
http://antwrp.gsfc.nasa.gov/apod/ap030422.html

ASTRONAUTS Astronauts remove the Wide Field and Planetary Camera to replace it with its more powerful successor, Wide Field and Planetary Camera 2, during Hubble's first servicing mission in 1993. The camera, shaped something like a grand piano, weighs 277 kg (610 pounds) on Earth, but nothing in space (though a significant push is still required to move the camera due to its inertia). It can detect stars a billion times fainter than the ones we can see with our eyes. Most of Hubble's most popular pictures have been taken with this 2nd camera.
Credit: NASA
http://hubblesite.org/gallery/spacecraft/15

Who Are NASA Earth and Space Science Explorers?

The Earth and Space Science Explorers series feature NASA explorers, young and old, with many backgrounds and interests. Most articles are written for three different reading levels: grades K–4, grades 5–8, and grades 9–12 and up. New articles are regularly added and can be accessed through the "For Educators" and "For Students" sections of the NASA portal: **www.nasa.gov/home.**

The complete collections of articles are available at:
EARTH EXPLORERS
http://science.hq.nasa.gov/education/earth_explorers
SPACE SCIENCE EXPLORERS
http://science.hq.nasa.gov/education/space_explorers
Note: Full-length feature articles on many of the Explorers profiled here are available online at the Web sites listed above. A few are slated for future articles.

Robert Bindschadler
Few people know cold and ice like Robert Bindschadler does. The longtime NASA scientist uses remote sensing to study glaciers and ice sheets. But sometimes an up-close-and-personal view is required. As a leader of more than a dozen Antarctic field expeditions, Bindschadler has had to sleep in tents through bitter cold, endure blizzards, and avoid falling into hidden cracks in glacial ice. "Blizzards can come up suddenly, and we never venture from our base camp without taking survival gear—shovel, small tent, sleeping bag, stove and food," he says.

Phil Christensen
Two things have fascinated Phil Christensen since he was a kid—Mars and rocks. In the sixth grade, he talked his mom into letting him stay home and watch the first images of Mars coming back from a NASA spacecraft. Now a professor and planetary geologist, Christensen has helped build several NASA instruments launched into space to map the Martian surface and study the history of water on Mars. As for rocks, Christensen now has more than he could have ever imagined. It was his idea to start the Rock Around the World program, which has collected more than 8,000 rocks sent in by students from all over the world. Scientists study the rocks and compare them with those found on Mars. "It's gratifying to see kids get excited about Mars," Christensen said. "For some of these students, this may be the beginning of a career in Earth sciences."

Michele Cooke
A day of observing fossilized dinosaur prints, petrified wood and volcanic rock would be a valuable learning experience for most any student, but especially for those who are deaf or hard-of-hearing. University of Massachusetts Amherst geologist Michele Cooke uses sign language to describe to high school students how tectonic forces deform rocks. One of the students' teachers, Mary Ellsworth, knows the importance of visual and hands-on methods in explaining science without benefit of the spoken word. "Sign language makes use of three-dimensional space in a different way than verbal language does," Ellsworth said. "Deaf students may be particularly adept at using this visual information."

Heidi Dierssen

Satellites allow for constant monitoring of the ocean's surface, but they have trouble seeing through to the ocean bottom. That's why NASA oceanographer Heidi Dierssen spends a good part of her research time collecting data on or underneath the sea surface. While the water she dives into is typically warm and only about 3 to 5 meters (10 to 15 feet) deep, it is not without its risks, which include strong currents and fish that can be way too friendly. "One time when the water was so turbid I couldn't see beyond my knees, a remora (also known as a suckerfish) came flying at me from the left and tried to attach itself to my bottom lip," Dierssen said. "'Ouch!' I think I screamed underwater. It apparently mistook me for a shark."

Jared Dmello

Located in a remote area of the Mojave Desert, the Goldstone-Apple Valley Radio Telescope was once used by NASA to track and communicate with spacecraft. Now, students such as Jared Dmello are controlling the telescope via the Internet. The California eighth-grader and his classmates have used the telescope's 34-meter (112-foot) antenna to study Uranus and Jupiter. Dmello has also worked with Hubble Space Telescope scientists on a science fair project involving the electromagnetic spectrum. "Since I was little, I always enjoyed looking at the stars," Dmello said. "I think it is so amazing to actually get to study Uranus and Jupiter, because you never know what you'll discover."

Jamie Dyk

Jamie Dyk came to NASA's Jet Propulsion Laboratory to help develop the Mars rovers Spirit and Opportunity. Not long after the young engineer arrived, she was faced with an unusual choice when she tried out for the Laker Girls, one of the world's most prestigious cheerleading squads. She made it to final cuts, only to realize there wasn't enough time in her life for both NASA and cheerleading. Ultimately, Dyk chose science over cheerleading, and to this day doesn't regret her decision. In fact, being an engineer has met and exceeded the expectations Dyk had when she first became interested in space and Mars as a middle school student. "I couldn't have imagined how cool it would be. There is nothing like sitting in the control room when the first images come back from Mars and you see your hardware sitting in the Martian dirt."

Esther, William and Alexander
Elementary schoolers Esther, William and Alexander helped to pilot Elementary GLOBE, a program designed to introduce K–4 students to the study of Earth system science. They worked with their teacher, Fran Bosi, and classmates at a New York City public school, to test an activity called Colors of the Seasons. Using a color chart, the students made observations outside during each of the four seasons, trying to find as many colors as possible and record what they saw. Their class then made charts describing the colors they found in each season. At the end of the school year, they compared their results for each season and developed conclusions about the variations in colors in nature both within and between seasons. "I like science because...I get to learn new stuff I never knew before," William said.

Paul Jones
Middle school science teacher Paul Jones says the key to getting kids interested in science is to expose them to a variety of science disciplines and activities. Jones does just that with his students at the School of International Studies at Meadowbrook in Norfolk, VA. Jones and his students have been featured in a NASA video about a group of satellites that fly in close proximity to provide detailed observations of the Earth system. They have also participated in an international video teleconference with students from France and scientists from NASA and Colorado State University. As a lead instructor at workshops focused on educational activities related to two NASA science missions—AIM and CALIPSO—Jones helps other teachers learn how to more effectively teach Earth and space science. "I've always had a fascination with space, technology and the environment," Jones said. "Science allows for critical thinking, problem solving, discovery and the sharing of information."

Thompson Le Blanc
How did Thompson Le Blanc become interested in astronomy? Le Blanc went to college at Metropolitan University in San Juan. One day he found an old telescope in a science lab there. He asked if he could use it, and before long he was hooked. Both Hispanic and African American, Le Blanc went on to become one of the first students to participate in a NASA and National Science Foundation program to boost the number of minorities pursuing advanced degrees and careers in space science. "I have had experiences where I have had people tell me that I could not [be a scientist]," he said. "I guess in part the reason why I am in it now is because I want to prove that I can do it."

Laurie Leshin
Laurie Leshin grew up enjoying the outdoors, especially rocks and stars. She has explored the universe as a student, a teacher and now a NASA scientist. Not even a failed mission to Mars—Leshin was on the science team that helped develop the Mars Polar Lander, which crashed when it arrived at Mars in 1999—has deterred her pursuit to find water and life in the solar system. Since then, Leshin has worked on a variety of NASA missions aimed at learning more about the solar system and universe. "The exploration you get to do every day as a scientist is one of the coolest things I can imagine being able to do," she said. "If you even think you want to be a scientist, make sure you take math and science courses, visit science museums, and take advantage of activities in your area where you can actually meet scientists and talk to them about what they do."

Lou Mayo and Kristina Krozak
For Lou Mayo, birthdays have never been the only reason to have a party. By second grade, the young sky watcher was having classmates over for "star parties" in his backyard. Taking a break from running around and yelling, Mayo and his friends would stop to look at the stars though his shiny new telescope. Now a NASA astronomer, Mayo is still learning about stars and other objects in space. He studies the lower atmosphere of Titan, Saturn's largest moon. Mayo enjoys nurturing a similar interest in up-and-coming scientists, such as middle school student and astronomy enthusiast Kristina Krozak, seen here with Mayo standing next to a solar telescope. "I want to help kids experience the same sense of wonder and excitement about the possibilities of space as I did," Mayo said.

Graeme Stephens
A scientist looking at clouds may think about their influence on weather and climate. An artist is more likely to view clouds as fluffy forms of white and gray that filter light and cast shadows. Graeme Stephens sees both the scientific and artistic sides of clouds. Stephens, the head scientist for CloudSat, a NASA satellite mission to observe clouds in greater detail than ever before, is also an artist. He has painted a series of pictures showing a variety of cloud types. "Art and science have much in common. And much has been written about the common threads between both," Stephens said. "Both, after all, are different expressions of the natural world around us."

Steven
Steven is blind, yet he was able to read the temperature with a thermometer and measure precipitation with a rain gauge at a summer science camp. His secret? Steven was using a talking thermometer and a rain gauge marked in Braille. The blind-friendly tools allowed Steven and others at the camp put on by the National Federation of the Blind and sponsored by NASA to make observations of the soil, vegetation, weather and birds. For many of the kids it was the first time they had used observation instruments specifically geared toward the senses of sound and touch, rather than sight. "I didn't know they existed," Steven said. "It was amazing to see the technology."

NASA's Science Mission Directorate

NASA's Science Mission Directorate (SMD) engages the nation's science community, sponsors scientific research, and develops and deploys satellites and probes to answer fundamental questions about our planet and universe. SMD seeks to understand the origins, evolution and destiny of the universe, and to understand the phenomena that shape it. SMD also seeks to understand the nature of life in the universe; the solar system, both scientifically and in preparation for human exploration; and the sun and Earth, including the relationship between the two and the consequences for life on Earth.

This Hubble Space Telescope face-on image of the spiral galaxy Messier 101 (M101) is composed of 51 individual Hubble exposures taken over nearly ten years, in addition to elements from images from ground-based photos. Credit: NASA and ESA

SMD has an essential role in NASA's education mission **"to inspire the next generation of explorers."** The discoveries and new knowledge from SMD missions and research programs consistently engage people's imaginations, inform teachers, and excite students about science and exploration.

NASA's SMD Web site—http://science.hq.nasa.gov

NASA Earth and Space Science Education

Learn more about NASA's SMD and its educational programs and resources by visiting the following Web sites.

★ **NASA's Science Mission Directorate Web Site** provides an overview of SMD and links to current news, mission Web sites, and educational programs and resources.
http://science.hq.nasa.gov

★ **The Space Science Education Resource Directory** is a convenient way to find NASA science education products for use in classrooms, science museums, planetariums and other settings. There are several ways to search this directory: by grade, subject or topic.
http://teachspacescience.org

★ NASA JPL has developed **Curriculum Standards Quilts,** which organize NASA space and Earth science education materials by national standards—science and mathematics—as well as California state science education standards.
http://quilt.jpl.nasa.gov

★ Subscribe to the **NASA Earth and Space Education Update,** a monthly email newsletter featuring the latest Earth and space science programs and resources for all levels of formal and informal education. To subscribe, send an email to:
esenewsletter@hq.nasa.gov
Back issues are available at:
http://science.hq.nasa.gov/education/edreports

★ **NASA's Earth Observatory** is an interactive Web-based magazine where the public can obtain new satellite imagery and scientific information about our home planet. Visit the Earth Observatory to read feature articles on wide-ranging Earth system science topics, download datasets and images for analysis, read breaking news, learn about current and planned Earth missions, search an online library for reference materials, and track natural hazards around the world in near-real time.
http://earthobservatory.nasa.gov

FOR THE CLASSROOM

NASA Earth and Space Science Explorers articles focus on science as a human endeavor. With new articles added regularly, the series offers a glimpse into the lives of people of all ages and backgrounds who embody the spirit of discovery, and who use NASA science and technology to explore from planet Earth to the far reaches of the universe.

Most articles are written for three different levels: grades K–4, grades 5–8, and grades 9–12 and up. K–4 versions of articles are typically intended as "read to" stories for K–2 or "read alone" stories for grades 3–4.

The full collection of articles are available at:

EARTH EXPLORERS
http://science.hq.nasa.gov/education/earth_explorers

SPACE SCIENCE EXPLORERS
http://science.hq.nasa.gov/education/space_explorers

Following are some suggestions for using these articles with students:

Introduce or Conclude a Topic
Articles from the *Explorers* series can be used as an introduction/gear-up activity or as a conclusion/extension of a related curriculum unit. Younger students can read the article, listen as the teacher reads the article or explore the article on their own in a reading center. Older students can read an assigned article or go online to identify and read articles as a launching point for an independent project.

Develop Communication Skills
Students can use the articles to develop communication skills by doing one of the following:

- Collect articles from newspapers or magazines that also show science as a human endeavor—something that people do, not just an accumulation of facts.
- Write a review of an *Explorers* article or articles, similar to a book or movie review.
- Interview scientists in their community and write their own *Explorers* article.
- Invite a local scientist into the classroom to discuss his/her background and career. The students can then write an *Explorers*-type article featuring that scientist.

Expand Knowledge of What Real Scientists Do
After selecting and reading several of the articles, small groups of students can discuss the following questions:

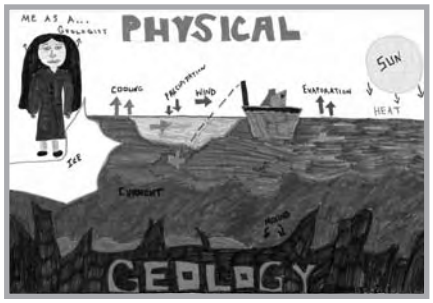
- What are some of the common characteristics shared by *NASA Earth and Space Science Explorers?*
  Possible answers include: curiosity/asking questions; ability to work well/collaborate with others; effective communication skills; someone who believed in and encouraged them (e.g., a parent, relative, teacher or mentor).
- Did any of the *Explorers* have barriers that they had to overcome? If yes, what were the barriers and how did they overcome them?
  Answers will depend on the articles chosen, and might include expectations (of themselves or by others) because of gender, ethnicity or physical disabilities; being the first person in their family to go to college; etc.
- How did the *Explorers* in the articles become interested in their project or career?
- After reading the article, did you learn something new or surprising about the *Explorers?*
- What did you find interesting about the *Explorers* in the article(s)?
- What questions do you have about these *Explorers* or their careers? How could you find the answers to questions about these careers?

NOTE: Not all articles will include information needed to answer all of these questions.

FOR THE CLASSROOM

Further Suggestions for Elementary/Middle School Students

Students can brainstorm and create a chart showing what they know about the work done by scientists. Have them explain how they know that information. After reading an article(s), the students can create another chart showing what they now know about scientists and their work. Compare the charts.



Entry from 2004 IGES art contest for grades 2–4.

Students can pick an *Explorer* on whom they will report. This report can be done as an individual or group assignment; the presentation could be oral or written.

Additionally, after reading *Explorer* articles, students can project themselves into the role of a scientist and write an article about themselves and their discoveries. Younger students could draw a picture of themselves as a scientist.

Credit: Elizabeth City State University

Further Suggestions for High School Students

Students can read an article and pick a related field that they find interesting (e.g., astronomy, meteorology, oceanography). Students can research the requirements for a job in that field (e.g., what type of degrees and preparation are required, what skills are necessary) and prepare a report. A group/class project might be to develop a resource center (online or hard copy) on science careers.

A marvelous panoramic view of Saturn was created by combining 165 images taken by the Cassini wide-angle camera on Sept. 15, 2006. Credit: NASA/JPL/Space Science Institute

Topic Index

Following is a list of selected topics related to *Earth and Space Science Explorers* feature articles. A complete, updated index of article topics is available at ***http://www.strategies.org/NASAExplorers.***

African American
Air Quality
Animal Habitats
Asteroids
Astronomy
Atmosphere
Big Bang Theory
Biology
Black Holes
Brown Dwarfs
Clouds
Coastal Areas
Comets
Dark Energy
Einstein
Engineers/Engineering
Forests/Forest Fires
Galaxies
Geospatial Technologies
Hispanic American
Hurricanes
Infrared
Mars
Meteorites
Meteorology
Moon
Oceans/Oceanography
Ozone
Polar Regions
Saturn/Titan
Space Weather
Spitzer Space Telescope
Stars and Constellations
Tree Rings/Climate Records
Urban Growth
Weather
Women in Science

earth and space science explorers

Connecting to the National Science Education Standards

The Earth and Space Science Explorers Series support the following science content standards (National Science Education Standards, National Research Council, 1995):

Content Standard G: History and Nature of Science
All students should develop understanding of science as a human endeavor.

GRADES K–4

- Men and women have made a variety of contributions throughout the history of science and technology.
- Although men and women using scientific inquiry have learned much about the objects, events and phenomena in nature, much more remains to be understood. Science will never be finished.
- Many people choose science as a career and devote their entire lives to studying it. Many people derive great pleasure from doing science.

GRADES 5–8

- Women and men of various social and ethnic backgrounds—and with diverse interests, talents, qualities and motivations—engage in the activities of science, engineering and related fields. Some scientists work in teams, and some work alone, but all communicate extensively with others.
- Science requires different abilities and qualities, depending on such factors as the field of study and type of inquiry.

GRADES 9–12

- Individuals and teams have contributed and will continue to contribute to the scientific enterprise. Pursuing science as a career or as a hobby can be both fascinating and intellectually rewarding.
- Scientists are influenced by societal, cultural and personal beliefs and ways of viewing the world.

Download this poster as a PDF file at:
http://www.strategies.org/NASAExplorers

Acknowledgments
Dan Stillman and Theresa Schwerin, Institute for Global Environmental Strategies, and Susie Duckworth, Duckworth Design Studio. Special thanks to Elizabeth Burck, 2006–2007 NASA Einstein Fellow; Teresa Hislop, Utah's Electronic High School; Constance Roth, Bay Waveland Middle School, Bay St. Louis, MS; and Linda Webb, retired Maryland elementary school teacher, for contributing to and reviewing the "For the Classroom" section of this poster.