A View from SPACE

Traveling Exhibit
Teacher's Guide

Welcome to ***A View from Space***, an interactive exhibition designed to introduce families and school groups to the Earth observing satellites. This guide provides resources to help you get the most out of your visit to ***A View from Space***.

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Introduction to *A View from Space*

Since the launch of the world's first artificial satellite Sputnik in 1957, satellites have dramatically changed the way we study our planet. ***A View from Space***, a new, bilingual (Spanish and English) traveling exhibit from the Oregon Museum of Science and Industry, gives museum visitors the chance to see the world from a satellite's perspective. In this highly interactive, hands-on science exhibit, visitors will be able to track a hurricane from space, send a satellite spinning into orbit around a model Earth, study astonishing images of our planet captured by NASA's Earth Observing System (EOS), and more. **A View from Space** is designed for a wide age range, with a special emphasis on children ages 5 to 12 and families.

NASA's EOS Mission

A key component of NASA's mission has always been to study the Earth and its changing environment by observing the atmosphere, oceans, land, ice, and snow and their influence on climate and weather. In 1991, NASA launched a more comprehensive program to study and advance the understanding of the Earth's systems on a global scale. A major component of this program is the Earth Observing System (EOS). EOS includes a series of satellites designed for long-term global observation of the land surface, biosphere, atmosphere, and oceans. Data from the EOS satellites will yield improved weather forecasts, tools for managing agriculture and forests, information for fishermen and local planners, and, eventually, the ability to predict how the climate will change in the future.

For more information about the EOS project, visit NASA's EOS website.

EOS satellites featured in the exhibit:

- Aqua
- Aura
- EO-1
- GOES
- Landsat
- QuickScat (SeaWinds)
- SeaWiFS / OrbView-2
- Terra

For details on these satellites, visit NASA's Earth mission science page.

A Note about Student Conceptual Difficulties

A View from Space is designed to introduce school groups and families with children age 5 to 12 to satellites and satellite imagery. Because this age group encompasses a broad range of cognitive development levels, certain concepts presented in the exhibit may be challenging to some young visitors. For example, early elementary students often have misconceptions about the shape of the Earth and the relationship between the movement of the Sun, Earth, and Moon. Young students also may find it hard to understand and interpret different perspectives of the Earth, including aerial photos and satellite images. The activities in this guide can be used to introduce students to these challenging topics.

PLANNING YOUR FIELD TRIP

Educational research has identified the following recommendations for making the most of your field trip.

Student knowledge of field trip setting and agenda is important.
Studies suggest that children in a novel environment initially focus their attention on learning about the setting rather than the instructional material. Prior information about the trip agenda (how we will get there, where we will park, what we will see, what we can buy, where we will eat, etc.) will enhance your students' educational experience. In one study, this kind of information enhanced learning more than prior information about the subject of the exhibit! (Of course, both are valuable.)

Prepare students with pre-visit activities.
For exhibit-related ideas, see the *Activities for Before and After Your Visit* section. The pre-visit activities can also include vocabulary words, reading and writing assignments, classroom projects, and related activities found in existing textbooks and recommended resources.

Follow-up with post-visit activities.
Post-visit activities help to connect the museum experience to the classroom. Exhibits at the museum may spark curiosity or interest, which can be of the basis for further learning in the classroom.

Help us evaluate your museum experiences.
Your feedback is vital for the evaluation and improvement of our exhibits and other educational offerings. Please share your comments with us during your visit.

EXHIBIT OVERVIEW

The content in this exhibition is organized around a single BIG IDEA:

- **Satellites change the way we see the Earth**

In addition, the exhibit addresses five questions:

- What are satellites?
- Where are satellites?
- What does the Earth look like from space?
- What can satellites tell us about the Earth?
- Why is the EOS mission important?

Below are brief descriptions of the exhibit activities in ***A View from Space***. Each description includes additional background info for teachers as well as key messages and activity challenges to help direct students during their visit.

SATELLITE ACTIVITY AREA
The satellite activity area features a drawing station, free-play activity table, and books. These activities encourage families and school groups to learn about space and satellites together through creative, open-ended play and exploration. For younger students with limited background knowledge, this is a good place to start.

Key messages: A satellite is an object in space; satellites are another way humans explore the Earth.

Student Challenge: Try using the stencils to draw a picture of a satellite orbiting the Earth. Now act out an orbit with the space toys.

SATELLITE PUZZLES
Two large floor puzzles help to make the topic of satellites accessible to families and young visitors. One compares the size of satellites to every day objects, such as a beach ball or a mini-van, while the other reveals the inner workings of NASA's Aqua satellite.

The size of a satellite depends on its mission and the number of sensors it carries. The largest satellite shown on the puzzle, Terra, has five different sensors, used to measure and map various characteristics of the Earth's lands, oceans, and atmosphere. Sputnik was the first satellite, successfully launched into orbit by the former Soviet Union in 1957. The only instrument aboard this small satellite was a thermometer.

Key message: Satellites can be big or small; there are many different parts to a satellite.

Student Challenge: How big is the largest satellite in the puzzle? The smallest? Why do you think most satellites have solar panels?

HOW HIGH ARE SATELLITES?
With this interactive, air-powered bar graph, visitors send balls shooting up a gigantic profile of the Earth's atmosphere, revealing the orbit and flight altitudes of satellites, space stations, weather balloons, and airplanes.

The last tube to the right on this exhibit shows the orbit of a weather satellite. Most weather satellites travel in geosynchronous orbit—meaning their orbit speed matches the rotation of the Earth. Satellites in geosynchronous orbit view the same part of the Earth at all times. To achieve this orbit, the satellite must be 22,300 miles from the surface of the Earth—over 50 times the altitude of NASA's Terra satellite.

Key message: Satellites view the Earth from space.

Student Challenge: How many miles above the Earth does the Terra satellite orbit? (Answer: about 440 miles.) How much higher is the Terra satellite than the International Space Station? (Answer: about 190 miles higher.)

ORBITS
This exhibit offers a dramatic demonstration of how satellites orbit the Earth and capture images of the entire planet. With the turn of a crank, visitors send a satellite spinning around a rotating model Earth, while a UV light paints a clear picture of the satellite's path.

This station models a polar orbit—the type used by most of NASA's Earth observing satellites. Because these satellites orbit around the North and South poles, while the Earth rotates from East to West, they are continuously capturing image "slices" of different parts of the Earth. By combining the slices, scientists create images of the entire planet.

Key message: An orbit is the path a satellite takes as it travels around the Earth.

Student Challenge: Turn the crank slowly and watch the satellite's path. Do you notice any pattern?

SEASONAL CHANGES
At this station, visitors spin a praxinoscope and see an entire year of satellite data from North America compressed into a few seconds of animation. Complex patterns of change are revealed as visitors watch cycles of drought, snow accumulation, and vegetation growth across the continent.

Images in this animation are taken from NASA's "Blue Marble: Next Generation" data set. This set of images was created using data from the MODIS (Moderate-Resolution Imaging Spectroradiometer) sensor aboard the Terra satellite and features a year of monthly composite images of the entire globe. NASA scientists used computer programs to remove clouds and enhance details in the images.

Key message: Changes on the surface of the Earth are visible from space.

Student Challenge: Spin the wheel. What changes do you notice? Why do you think the color of the East coast changes so much during the year?

ENVIRONMENTAL CHANGE

At this exhibit, three rotating cubes, featuring modern and historic satellite images, demonstrate some of the important environmental changes that NASA's satellites are tracking from space, including population growth, deforestation, and ozone depletion. All three of these continue to be important issues today.

Another environmental problem being studied by NASA is global warming. Many of the Earth Observing System satellite missions are designed to help scientists better understand and monitor global climate change. To learn more about climate change, visit the Earth Observatory website:
http://earthobservatory.nasa.gov/Library/GlobalWarming/warming.html

Key message: Satellites are helping us study important environmental changes.

Student Challenge: Between which years did the most deforestation happen in Brazil? What other types of change could you track from space?

THE BIG PICTURE

This flip panel matching game challenges visitors to expand their point of view and try to identify the Grand Canyon from a series of ground photos, aerial photos, and satellite images. A giant topographical map of the canyon gives visitors a hands-on appreciation of a satellite's perspective.

The vertical scale of the Grand Canyon relief map is 1:125,000. Aerial photos in the exhibit were taken from an altitude of approximately 20,000 feet and the satellite photos were from 440 miles above the Earth. On the scale of the map, an airplane would be just two inches above the Grand Canyon, while a satellite would be almost two stories above the map!

Key message: The Earth looks very different from space.

Student Challenge: What part of the Grand Canyon is shown in the aerial photo? In the satellite image?

WHAT CAN YOU FIND?

A large banner features a wide-view image of North America on one side and a detailed, 1-meter resolution image of downtown Manhattan on the other. Visitors are introduced to the importance of scale and resolution as they compare these images captured by the IKONOS and SeaWiFS satellites.

The SeaWiFS satellite is designed to look at ocean color variation. This information can be used to map types and quantities of marine phytoplankton. IKONOS is a privately owned satellite that produces high-resolution imagery for a variety of applications, including oil and gas exploration, agriculture and land management, environmental analysis, and even motion pictures.

Key message: Satellites give us a new perspective of our planet.

Student Challenge: Look at the satellite image of Manhattan—how could scientists use such a detailed image? Now look at the image of North America—how could scientists use this image? (Possible answers: locating forest fires, tracking storms, map-making.)

IMAGE GALLERY

This two-sided banner shows ten images of the planet, each created using data from a different satellite sensor. Most satellite sensors collect data by measuring different wavelengths of light. For example, the MODIS sensor on the Terra satellite can measure long wave infrared radiation. This information allows scientists to create global temperature maps of the oceans and lands. The TOPEX/Poseidon satellite, in contrast, used radar to measure ocean surface heights. This data can also be used to calculate ocean temperatures.

For the large "Blue Marble" image, cloud, land, and ocean data were collected by three different satellites: the Geostationary Operational Environmental Satellite (GOES), the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) satellite, and NOAA's Polar Orbiting Environmental Satellite (POES). In the image a powerful hurricane is visible in the Eastern Pacific, just below Baja California.

Key message: Satellites give us a new perspective of our planet.

Student Challenge: Study the large image of the Earth. What interesting features can you find? Do you see a hurricane?

SATELLITE VISION

At these specially designed illusion boxes, visitors turn a knob to fade between true-color and false-color satellite images. The first box features sea surface temperatures in the Atlantic Ocean and clearly shows the swirling eddies and currents of the warm Gulf Stream (warm water is red and yellow, cooler water is green and blue). The other box shows atmospheric concentrations of the pollutant carbon monoxide over Central America (higher pollution areas are red and yellow, cleaner air is green). Wildfires and agricultural fires were responsible for much of the pollution seen in the image.

Key messages: Satellites can detect information that is invisible to the human eye; satellite data is used to answer questions that are important to our daily lives.

Student Challenge: Look at the pollution image—is there more pollution over the ocean or the land? Now look at the ocean temperature image—where in this picture would you want to go swimming?

TRACKING HURRICANES

This interactive hurricane-tracking map tells visitors the story of Hurricane Charley and challenges them to predict Charley's landfall location. Visitors use a magnetic hurricane "puck" to trace the path of the hurricane and discover how satellites are used to study these awesome storms.

Charley began in August 2004 as a small weather disturbance moving east from Africa. On August 10 it strengthened to a tropical storm and then to a hurricane on August 11. It struck the United States on the afternoon of August 13, causing an estimated 15 billion dollars in damage. Charley's dramatic, last minute curve to the Northeast was due to a strong weather pattern, known as a "mid-tropospheric trough," that had moved in to the Gulf of Mexico from the east-central United States and pushed the hurricane towards the southwest coast of Florida.

Key message: Satellites allow us to monitor and predict natural disasters, such as hurricanes.

Student Challenge: Complete the activity and try to guess where Hurricane Charley hit the United States. What clues did you use to make your decision?

ACTIVITIES FOR BEFORE AND AFTER YOUR VISIT

Activity	Grade (s)
1. Mapmaking	1, 2, 3
2. Earth Puzzle	2, 3, 4, 5
3. Parts of a Satellite	5, 6, 7

Notes:
The images required for these activities are available on the OMSI website. Teachers may wish to download additional images from NASA or NOAA (National Oceanographic and Atmospheric Administration). Unless noted on the website, imagery from these two agencies are in the public domain and are not copyrighted.

It is recommended that teachers try activities before assigning them in class.

See Additional Resources section for links to NASA curriculum.

ACTIVITY 1: MAPMAKING

(Adapted from NASA's Mars and Earth Educator Resource Guide)

Summary:
Students are introduced to a "satellite's perspective" as they create drawings and maps of their classroom.

Grade Level: 1–3 (This activity can be adapted to meet the specific needs of your class.)

Time: 45 minutes

Learning Objectives:

- Students explore different perspectives of their world
- Students think about what the Earth looks like from space

Materials:

- Paper and drawing materials for each student
- Graph paper (optional)
- Globe and state maps (optional)
- Satellite images (optional)

Background:

Early elementary students may have difficulty interpreting satellite images of the Earth. Use this activity to introduce students to this new perspective.

Activity:

1. Start the activity by asking students to draw a picture of the classroom. Students can choose any perspective they want (e.g., from the side or from above).

2. Have students share and discuss their drawings. How are they different? How are they the same? Did anyone draw the room as if they were looking down from the ceiling?

3. Have students draw a map of the classroom. (Optional: use graph paper.) Students should create these maps as if they were looking down at the classroom from the ceiling—as a bird would see the world. Discuss why this type of drawing might be helpful.

4. Ask students to imagine they are looking down at the Earth from space. What things can they see? Use a globe or a map of the state to help students brainstorm. If available, show the class several satellite images and ask students to point out features that they recognize. (An extensive collection of satellite imagery is available at NASA's Visible Earth.)

Students can try Activity 2 to explore a large satellite image of the Earth.

ACTIVITY 2: EARTH PUZZLE

Summary:
Students assemble a large puzzle showing a satellite image of the Earth.

Grade Level: 2–5 (This activity can be adapted to meet the specific needs of your class.)

Time: 30 minutes

Learning Objectives:
- Students practice looking at the Earth from a satellite's perspective

Materials:
- Drawing and art supplies for each student
- Paper for each student
- Set of Earth puzzle images for each group (available on the OMSI website)
- Tape (transparent mending tape, like Scotch Magic Tape)

Note: This activity works best if the images are printed in color. Teachers can also laminate the images to create a permanent floor puzzle.

Background:

Earth Observing Satellites
When people think of satellites, they often think of communication satellites used to send TV or cell phone signals. Most people are less familiar with the Earth observing satellites used by scientists to study the Earth's land, ocean, and atmosphere systems. From space, satellites can make repeated measurements of large areas over long periods of time, giving us new insight into how our planet is changing.

A familiar example of an Earth observing satellite is a weather satellite. Weather satellites bring us the images of clouds and weather patterns we see on TV every day. From the ground, it is difficult to study these patterns. From space, however, we can watch as the entire atmospheric system changes over time. This information is used to make more accurate and longer-term weather forecasts.

Blue Marble
The blue marble image used in this activity was created using data from three different satellites: the Geostationary Operational Environmental Satellite (GOES), the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) satellite, and NOAA's Polar Orbiting Environmental Satellite (POES). In the image a powerful hurricane is visible in the Eastern Pacific, just below Baja California. To learn more about this image, visit this NASA website: http://visibleearth.nasa.gov/view_rec.php?id=174

Activity:

This activity may be done with the whole class or in small groups.

1. To introduce the activity, ask the students first to imagine what they think the Earth would look like from space. Have them try to draw it with crayons, markers, paints, watercolors, or even collage.

2. Hand out the Earth image pieces and have students try to complete the puzzle. It may help students to first put together the pieces showing the edge of the Earth and then fill in the middle.

3. After completing the puzzle, students can tape the pieces together and hang the image on the wall. This is what the Earth looks like from space! As a class, label all the features on the image that students recognize (e.g., rivers, mountains, continents, clouds, etc.). Use a globe or a map to help.

ACTIVITY 3: PARTS OF A SATELLITE

Summary:
Students learn about the basic components of a satellite and relate them to objects in their everyday lives.

Grade Level: 5–8 (This activity can be adapted to meet the specific needs of your class.)

Time: 45 minutes

Learning Objectives:

- Students learn that a satellite is a machine made of many components and many types of technologies
- Students identify technology in their everyday lives that resembles or serves the same function as technology found on a satellite

Materials:

- Copy of “Parts of a Satellite” article for each student
- Magazines with images of common technologies
- Examples of everyday technology, like cell phones and digital cameras (optional)

Background:

(See “Parts of a Satellite” article)

While a satellite is built specifically for space studies, the parts that make a satellite function can be found in everyday life.

For example:

The *Equipment Bus* is similar to

- A laptop computer. Satellite computers and laptop computers both store data and processes information.
- A thermostat. This device measures temperature and regulates how hot your house gets. Satellites use similar instruments to measure and control the on-board temperature.
- Light or appliance switches. Computers on the satellite bus control electronic switches that turn radios, imagers, and other electronic devices on and off.

The *Power Supply* is similar to

- Photovoltaic cells, or solar panels. These are found in solar powered devices like calculators and decorative home lighting.
- Rechargeable batteries. Cell phones, radio controlled cars, and electric toothbrushes all have rechargeable batteries. A satellite uses batteries, which are charged by the solar panels, when it is in the Earth’s shadow.

The *Communication System* is similar to

- Cell phones or toy “walkie talkies.” Satellites have two-way communication devices like cell phones and “walkie talkies” to receive information and instructions (known as the “uplink”) and send information and data back to Earth (know as the “downlink”).
- Wireless computers or personal data assistants. These use a radio link to receive and transmit data.

The *Sensor Platform* is similar to

- Digital cameras. Like a satellite sensor, digital cameras create pixilated images and store information in a digital format.
- An ear thermometer. Modern thermometers measure body temperature by detecting infrared light. Satellites use similar technology to measure the temperature of the Earth’s oceans and atmosphere.
- A cell phone with camera. This technology is remarkably like a satellite. It is only missing the solar panels! It has an imaging sensor (the camera), a rechargeable battery, and a communication system to send pictures to other cell phones.

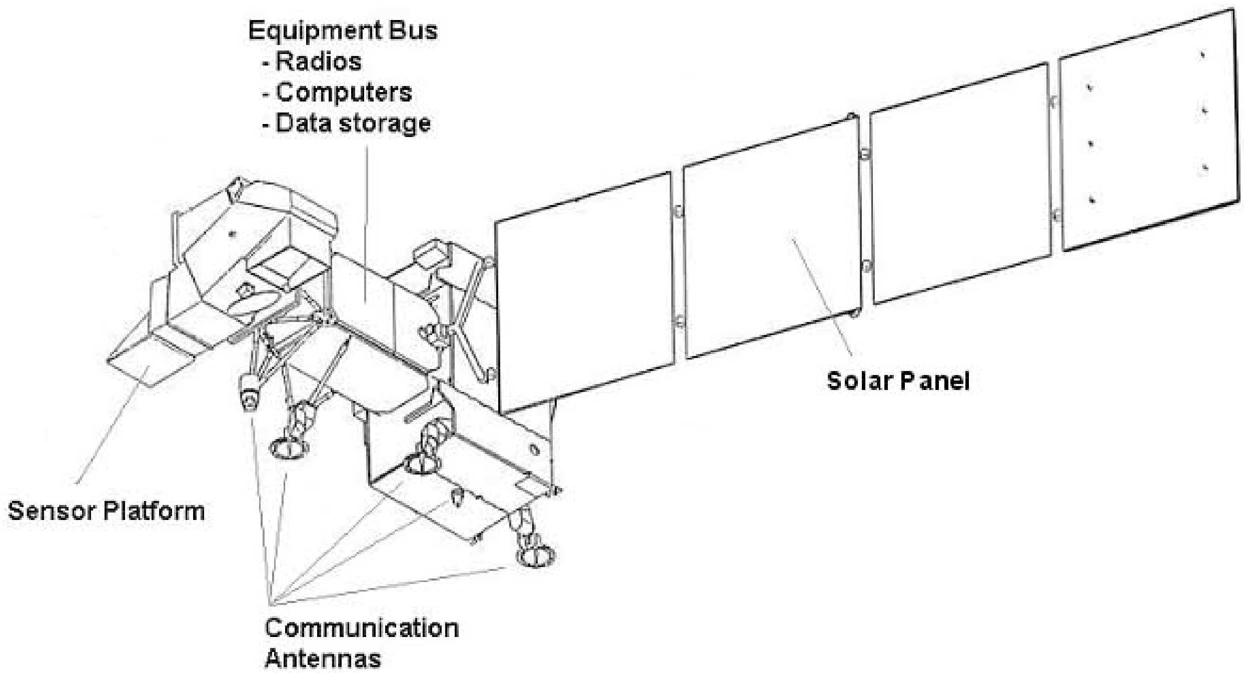
Activity:

1. Ask students to read the “Parts of a Satellite” article. Then review the four primary parts of a satellite and their function.

2. As a class, brainstorm examples of technologies that resemble or perform the same function as the parts of a satellite. (Optional: collect some of these devices to show during the activity.)

3. Use the students’ brainstorm and images of everyday technologies to create a collage highlighting the function of different satellite parts.

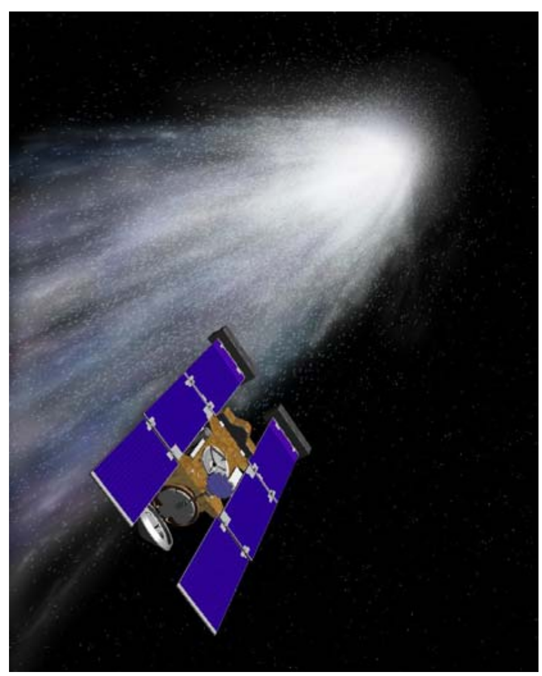
PARTS OF A SATELLITE



What is a satellite?

Satellites are like space laboratories. They are used to study the Earth, as well as other objects in space, such as planets, the moon, the Sun.

Satellites capture images of different objects, such as the Earth, or they can make measurements. Satellites can measure temperature, magnetic fields, gravity strength, and more.



Parts of a Satellite

The main parts of a satellite are:

Equipment Bus
This is the heart of the spacecraft. The electrical systems and the computers that control the spacecraft and store data collected from the sensors are found on the bus. The bus also has the maneuvering engines (or thrusters) and engine fuel.

Power Supply
Most satellites use solar panels to generate electricity for the spacecraft. All the electronics, communication systems, and sensors require electricity. Most satellites spend half of every orbit in darkness as they go through the night side. This means they depend on batteries to power the equipment when the sun is out of sight.

Communication System
Collecting data and getting it to the Earth is the satellite's goal. To accomplish this, satellites need a communication system to send information to the Earth and to receive instructions. Most spacecraft have two or more communication systems on board in case one fails.

Sensor Platform
Sensors allow satellites to collect information, such as pictures of the Earth or temperature readings from the oceans. These sensors are mounted in various places on the bus. In some cases, one spot (the sensor platform) is home to all the sensors.

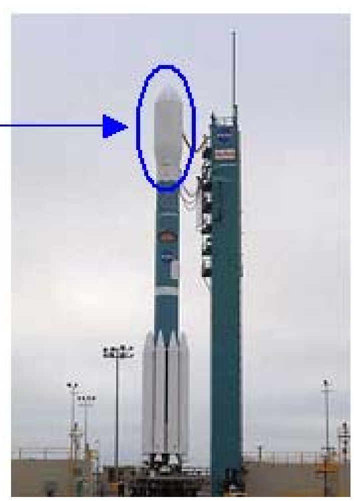
How big are they?

The size of a satellite depends on its mission. NASA’s Aura satellite has a bus as big as a UPS delivery truck. Most satellites are closer to the size of a car. Solar panels make satellites look larger.

This is the Aura satellite before being launched. It is folded so it can fit into the launch rocket.

A UPS truck is about the same size as the Aura satellite.

The Aura satellite is here.



Additional Resources

BOOKS

Books for Teachers and Older Students

Curtis, A. R. ***Space Almanac, 2nd Edition***. 1992. Gulf Publishing. An all purpose stats book for satellites.

Emanuel, K. ***Divine Wind, The History and Science of Hurricanes***. 2005. Oxford Press. Introduces the history and science of hurricanes.

Johnston, A. K. ***Earth from Space***. 2004. Firefly Books Ltd. An incredible collection of satellite imagery of the Earth.

Books for Younger Students

Barton, B. ***I want to be an astronaut***. 1992. HarperCollins.

Graham, I. ***Space Travel***. 2004. Dorling Kindersley.

Manning, M., and B. Granstom. ***What's Up***. 1997. Franklin Watts.

Rogers, K. ***Earth and Space***. 2001. Usbourne.

Walker, N. ***Satellites and Space Probes***. 1998. Crabtree Publishing Company.

Spanish Books

Dowswell, P. ***Mi Primera Enciclopedia del Espacio***. 2003. E.D.C. Publishing.

WEBSITES

Satellite Imagery and Data

http://visibleearth.nasa.gov/ *NASA Visible Earth*

http://svs.gsfc.nasa.gov/index.html *JPL Visualization Studio*

http://rapidfire.sci.gsfc.nasa.gov/ *MODIS Rapid Response*

http://terraserver.microsoft.com/default.aspx *Terraserver*
Aerial photographs of the U.S.

http://geospatial.amnh.org/remote_sensing/index.html
American Museum of Natural History: Remote Sensing Resources

http://neo.sci.gsfc.nasa.gov/Search.html *NASA Earth Observations*

Online Curriculum

http://www.nasa.gov/audience/foreducators/k-4/features/index.html
NASA site for educators

http://www.nasa.gov/education/materials
NASA educator guides, classroom activities, posters, lithographs, brochures, and bookmarks

http://www.nasa.gov/education/express *NASA Education Express Mailing List*
Sign up for announcements about NASA products and activities.

http://www.omsi.edu/visit/earth/eyesonearth/
OMSI's *Eyes on Earth* exhibit teachers guide (grades 3–8)

http://imagers.gsfc.nasa.gov/index.html *The Adventure of Echo the Bat* (grades 5–8)

http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Cool_Suits_Activity.html *Cool Suits* (grades 3–5)

http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Mars_and_Earth_Educator_Guide.html *Mars and Earth* (grades K–5)

http://www.mcps.k12.md.us/departments/eventscience/rs.index.html *NASA Event-Based Science* (grades 5–8)

http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Space.Based.Astronomy.html *Space-Based Astronomy Curriculum* (grades 5–8)

http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/3-2-1.Liftoff.html
321 Liftoff (grades K–2)

http://trmm.gsfc.nasa.gov/education_dir/education.html *TRMM problem-based classroom modules* (grades 5–8)

NASA

http://www.nasa.gov/home/index.html?skipIntro=1 *NASA Homepage*

http://eospso.gsfc.nasa.gov/ *NASA Earth Observing System Homepage*
Introduction to the EOS program and satellite missions. Includes a great set of posters which introduce the EOS mission.

http://earthobservatory.nasa.gov/ *Earth Observatory*
Extensive archive of information and images related to the EOS mission—a good first stop for information related to the EOS mission

http://science.hq.nasa.gov/info/sitemap.html *NASA Science*
A clearinghouse for NASA science resources

http://spaceplace.jpl.nasa.gov/en/kids/ *NASA Space Place*
Great site for students.

Other "Not to Miss" Sites

http://www.omsi.edu/visit/earth/eyesonearth/
Official website for OMSI's *Eyes on Earth* exhibit

http://science.nasa.gov/Realtime/JTrack/eos.html
Real time satellite tracking

http://science.howstuffworks.com/satellite.htm *How Stuff Works: Satellites*

http://edcwww.cr.usgs.gov/earthshots/slow/tableofcontents *USDA Environmental Change*

http://ozonewatch.gsfc.nasa.gov/index.html *Ozone Watch*

http://rst.gsfc.nasa.gov/start.html
NASA remote sensing tutorial

http://imagers.gsfc.nasa.gov/ems/ems.html
Introduction to the electromagnetic spectrum

http://www.nhc.noaa.gov/index.shtml *National Hurricane Center*

