Pre-Classroom Activities

9-12 Activity #1

Article: Your View From Above

Thanks to an innovative NASA education program, students can enjoy one of the benefits of being an astronaut without ever leaving the Earth. There are many exciting things about going on a spaceflight. But, one thing mentioned by most astronauts as a favorite part of the experience is looking down at the Earth. The view of our planet from space is incredible, they say. There's nothing on Earth like looking at the Earth from off the Earth. When astronauts give talks after their missions, they often show off with pride pictures they took while in space. And, those pictures are definitely special. National boundaries disappear. Everyday scenes take on a new beauty. Familiar landmarks are lost from the new perspective. Mount Everest, the tallest mountain on the planet, becomes another peak lost among others. Major events can become lost in the detail, and minor details can stand out from the background. The pictures show us our world in ways we've never seen it before. Wouldn't it be incredible to get the opportunity to take those pictures yourself? What would you want to photograph from the International Space Station (ISS) if you got the chance?

A NASA program gives students the opportunity to do just that. The ISS EarthKAM (Earth Knowledge Acquired by Middle school students) lets students, teachers, and the public learn about Earth from the unique perspective of space. The program uses a digital camera in the ISS pointed towards Earth. Classrooms participating in the ISS EarthKAM program can select sites on Earth they would like to photograph with the camera. These classrooms become "Student Mission Operations Centers," where students target, request, and retrieve images. Students study atlases, weather information, and the ISS's orbital path in the process of making image requests. Following the mission, they prepare presentations explaining their analyses of the images they took of Earth.

Other resources are also available to teachers and students through the program. All of the images of the Earth (over 16,000) taken by students are available online through the EarthKAM Datasystem Web site (http://datasystem.earthkam.ucsd.edu). The images can be used to help students learn about geography and Earth resources. The program also offers educational materials for teachers to use in their classrooms. You don't even have to be a teacher or student to take advantage of ISS EarthKAM resources. Anyone who is interested can browse through the archive of photographs of the Earth from space.

ISS EarthKAM was the idea of Sally Ride, the first American female in space. It began with a program called KidSat. The KidSat camera flew on three Space Shuttle missions in 1996 and 1997. A total of 1,495 images, requested by students at specially selected schools, were taken on those three flights. The KidSat pilot program was deemed successful, and the EarthKAM program was created. The first EarthKAM flight was the STS-89 Space Shuttle mission in January 1998, on which 490 photos were taken. EarthKAM flew a second and final flight on the Shuttle on STS-99 in February 2000. A total of 2,715 photos, requested by students at 83 schools, were taken on this mission. In 2001, the name of the program was changed again to "ISS EarthKAM" (due to placing the camera on the ISS rather than on the Shuttle). ISS EarthKAM was launched on the STS-98 Shuttle mission in February 2001 as part of the Station module Destiny. In fact, ISS EarthKAM was the first operational payload in NASA's science laboratory module. It was set up on May 6, 2001, and takes pictures through Destiny's window. This window is where astronauts do most of their Earth gazing. Now that the EarthKAM is on ISS, students no longer have to wait for a Shuttle flight to participate in the program. Instead, new EarthKAM missions begin about every 3 months.

The ISS EarthKAM program recently launched its eighth year of operations with the first mission of the 2004-2005 school year beginning in October. Additional ISS EarthKAM image **acquisition** and investigation missions are scheduled in February and April 2005. ISS EarthKAM is currently registering schools interested in participating in this year’s missions. Teachers can register for this free program through the ISS EarthKAM on-line registration system (http://datasystem.earthkam.ucsd.edu/ekReg/ekRegistration.shtml).

ISS EarthKAM is made possible by the cooperative work of undergraduate students and their advisors. Some of the organizations involved are the University of California, San Diego; NASA's Jet Propulsion Laboratory; NASA's Johnson Space Flight Center; TERC (a nonprofit educational research and development company); and middle school students and teachers around the world. Learning about geography and ecology has been an important part of students' lessons for a long, long time. But, with ISS EarthKAM, NASA has given today's students a whole new way of looking at these subjects.

Change In Perspective

Teacher Sheet(s)

Objective: To view various objects from different perspectives.

Level: 9-12

Subjects(s): Geography

Prep Time: 10-30 minutes

Duration: 30 minutes

Materials Category: Common Household

Materials:

- Student Sheets
- Familiar objects (coffee mugs, garden utensils, hats, action figures, etc.)
- Colored pencils

Related Links:

Lesson adapted from:
ISS EarthKAM—From Above

GlobeXplorer—Image Atlas

Space Imaging

Supporting Article(s):

Your View From Above

Pre-Lesson Instructions:

- Duplicate the Student Sheets (one per student). This activity can also be done in groups. This will depend on the amount of items that you have available.
- Bring to class numerous items that are readily recognizable from one vantage point, but maybe not from another. Or, bring in items that are not symmetrical, so the change in perspective will change the sketch completed by the students. Some suggestions are coffee mugs, hats, garden utensils, books, doll house, action figures, etc.

You can also include more symmetrical items, to add some comparison aspects, like sporting event balls or cardboard boxes.
- Complete the second part of the activity from a balcony or second story (or higher) vantage point of the ground. (You can skip this step if these are unavailable.)

Background Information:

The launch of the first environmental satellite by the United States on April 1, 1960, dramatically changed the way we observe Earth and the frequency of those observations. Looking at Earth from space meant that monitoring the atmosphere was transformed into a global capability and perspective. Isolated local information became a component in a worldwide view of the atmosphere. The polar ice caps and the large areas of Earth's surface covered by water could remain inaccessible to ground observers, but that did not stop information from being obtained by remote sensors.

Sophisticated technology enables and challenges us to:

- observe the changing Earth system,
- identify the changes caused by nature and those effected by humans,
- understand those interactions,
- assess the impact of those changes, and
- eventually, predict change.

Technology provides constantly improving tools for conducting this task, but scientific knowledge, observation, assessment, and prediction are the objectives that drive it forward.

Remote sensing is the ability to acquire information about an object or phenomenon by a device that is not in physical contact with that object. Direct readout is the capability to acquire information directly from environmental satellites. Users of ground station equipment can obtain real-time data from environmental satellites. Data can be displayed on a personal-computer screen as images of Earth (similar to those seen on television weather forecasts). This exciting capability is impacting the way many students now study Earth, and providing many with experience using first-hand satellite data. The practical utilization of technology has real merit in preparing students for future careers. But more importantly, direct readout technology transforms them into explorers. This experience can spark interest in science and math, further understanding of our planet, and provide a clearer perspective of our individual and collective responsibilities as caretakers of Earth. It underscores the importance of international cooperation for observing Earth and developing strategies to preserve it.

Guidelines:

1. Read orally the 9-12 article, "Your View From Above."
2. Distribute Student Sheets.
3. Place various items around the classroom. Leave enough room for students to walk up to them and lean over top of them.
4. Instruct students to go to each item and look at it from the side and sketch what they see.
5. Instruct students to lean over top of each item and sketch what they see.
6. Have students do this for each item.
7. Gather up the items and travel to a place where the students can see the ground from a second- or third-story vantage point above it.
8. Have students sketch each item again from this height.
9. Return to the room and have students answer the questions at the end.

Discussion/Wrap-up:

- Discuss how perceptions can be different, even contradicting, yet all parties involved can be correct. As an example, stand in the middle of the room facing your students. Ask the ones on the left where you are standing in reference to them. Then, ask the students on the right where you are standing in reference to them. Discuss how both sets of students gave different answers, yet they were both right.
- Ask students, "Obviously, you can recognize your house from the front, back, or side, but could you recognize your house from the sky? What about your neighborhood? Your school?"
- Students should find that as they complete this activity, objects can have very different looks based on the angle of observation. Viewing them from above (especially from the higher vantage point) should reinforce this.
- Some advantages (there are others) to remote sensing: able to go places where no one else can, to get a "big picture" view of the Earth, and to help with weather prediction.
- Some disadvantages to remote sensing: cannot see with too much detail, can be blocked by obstructions (natural and man-made), and

very expensive.

Extensions:

- Next time your students travel by plane, have them try to determine where they are (or even find their house) during takeoff or landing.
- Go to any one of various sites and print out a picture of the school taken from a satellite (see Related Links section). Display the picture and ask if they know what it is or where it was taken. It would help to print this picture in color.

Change In Perspective

Student Sheet(s)

Background Information

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Procedure

1. Go around to each item displayed by your teacher.

2. Fill in the spaces provided with the type of object (name or description), a sketch of what it looks like from the side, and a sketch of what it looks like from above.

Type of Object	Side View	Top View

3. If available, view the same items from a much higher vantage point (for example, balcony, bleachers, or window).

4. Sketch the item again from this height.

Type of Object	**"Satellite" View**

5. Answer the following questions:
   a. Each sketch will probably be different. Why? Shouldn't the same object have the same sketch regardless of angle of observation?
   b. What differences did you notice from viewing the object from leaning over it to standing way above it?
   c. What advantages would an orbiting satellite have in taking pictures of the Earth?
   d. What disadvantages would an orbiting satellite have in taking pictures of the Earth?
   e. Based on your sketches, do you think a person looking at them could tell what they are? Why or why not?

9-12 Activity #2

Article: Flying on the Ground

Wind tunnels are used to test models of aircraft before the actually plane is built. Wind tunnels are tube-like enclosed structures where wind is produced, usually by a large fan, to flow over objects such as aircraft, engines, wings, rockets, or models of these objects. These tunnels simulate the same conditions an aircraft would encounter as it flies through the atmosphere. This allows researchers to measure the airflow around the object and the aerodynamic forces that act upon it. Gathering this data is often impossible while a vehicle is in flight. Wind tunnels are so effective in testing systems and vehicles that no aircraft, spacecraft, or launch vehicle is built or committed to flight until its design and components have been thoroughly tested in a wind tunnel.

NASA has 42 wind tunnels distributed through several of its centers, with the majority of tunnels located at Ames, Langley, and Glenn Research Centers. Tunnels are built to test for certain conditions. Their names reflect either the size of their testing area, or their function. As the designations indicate, for example, the 10 by 10 tunnel has a testing area that is 10 feet high and 10 feet wide (approximately 3 meters by 3 meters), and the Icing Research Tunnel simulates cold weather conditions. Various tunnels examine propulsion, spin control, and numerous other concerns.

Wind tunnels can have open, closed, or dual cycles. In open-cycle tunnels, the wind comes in one end and goes out the other end. The air is muffled and exhausted to the outside in a controlled discharge. Open cycles are used in instances where byproducts are emitted during the test, and the air cannot be circulated. During engine tests, combustion exhausts require open-cycle testing. Closed-cycle operations recirculate the air repeatedly through the use of high-powered motors. Dual-cycle testing uses both methods of air circulation at different points in the testing process.

Large compressors are used to generate the tremendous airspeeds required for testing. The 10 by 10 wind tunnel uses two compressors that together can move 100,000 cubic feet (929 cubic meters) of air per second. This is equivalent to the air in 20 average sized houses. The compressors are powered by a series of 40,000-horsepower electric motors. The air from the compressors must be channeled through a nozzle and accelerated. Just as putting your thumb over the end of a garden hose will make the water go faster and farther, the airspeed in the 10 by 10 can be increased by flexing (pinching) the stainless steel sidewalls of the tunnel. Each wall is 1-3/8 inches (3.8 centimeters) thick, and hydraulic jacks pinch these walls and control the contour to within 5 thousandths of an inch (.12 millimeters). This is less than the thickness of a sheet of paper.

What do wind tunnels test? It all depends on the tunnel. A few examples include:

- NASA Glenn's 9- by 15-foot low-speed tunnel reproduces cross-flow conditions that are present on vertical and short takeoff. Cross flow is air traveling in different directions. It occurs when aircraft change from hover to horizontal flight and back to **hover**. The 9 by 15 tunnel has also been used for researching how hot engine exhaust gases flow around the aircraft when it is near the ground, and has more recently been used to test aircraft traveling at low speeds during takeoff and landing. It is also equipped with 20 microphones to test for and monitor noise at takeoff and landing.

- The Icing Research Tunnel (IRT), at NASA Glenn, simulates actual flying conditions, but instead of just wind, the tunnel produces artificial clouds and low air temperatures necessary to study how ice forms on aircraft. An enormous air conditioner, powerful enough to cool 600 homes, cools the area to -28 degrees Fahrenheit (-33.3 degrees Celsius). Nozzles in 10 spray bars produce supersonic water droplets in a cloud that freeze when they strike something, just as cloud droplets freeze when they strike an aircraft. The IRT was built during World War II to reduce the number of aircraft accidents as supply planes flew over the Himalayan Mountains.
- The National Transonic Facility at NASA Langley evaporates super-cold liquid nitrogen and accelerates it through the tunnel's test sections at speeds up to 1.2 times the speed of sound. The combination of low temperature and high speed simulate conditions of **transonic** speeds.
- The **Subsonic** tunnel at NASA Ames is the largest wind tunnel in the world. It can test planes with wingspans of up to 100 feet (30.5 meters), and is over 1,400 feet (426.7 meters) long and 180 feet (54.8 meters) high. Each fan in this tunnel has a diameter equal to the height of a four-story building.
- The 1-by-1 foot Supersonic Wind Tunnel simulates flight speeds from supersonic jet fighters that travel at twice the speed of a rifle bullet. The tiny wind tunnel saves money by testing small models before full-sized components are built.

One of the biggest challenges with wind tunnels is that wind is invisible, so it's hard to track its movement and effects on aircraft. *Flow visualization techniques* help makes the wind and its effects "show up" better. Ultraviolet oil, paint, and fluorescent mini-**tufts** (short strings) move as the air moves and accentuate what scientists need to see. Temperature-sensitive paints and microphone arrays illustrate heat and sound variations that are also tested in wind tunnels.

Wind tunnels aren't new to aviation. The Wright brothers designed and used tunnels to develop wing configurations and control surfaces needed to achieve the first powered human flight in the early 1900s. Early researchers realized that an aircraft's shape, construction, and materials influenced its ability to climb and carry loads, and they discovered that subtle variations caused changes in air resistance and affected speed, fuel economy, and other flight characteristics. Current wind tunnels are more sophisticated than those used by early aviators, however. Scientists use computers and flight simulators along with the tunnels to learn about the characteristics of new aircraft designs and modifications.

Remotely Sensing

Teacher Sheet(s)

Objective: To analyze satellite images using algebra.

Level: 9-12

Subjects(s): Geography, Mathematics, Science, Technology

Prep Time: Less than 10 minutes

Duration: 30 minutes

Materials Category: Special Requirements

Materials:

- Student Sheets
- Computers with Internet access
- Calculator (optional)
- Color printer (optional)

Related Links:

Lesson adapted from the following NASA site:
NASA's Jet Propulsion Laboratory (JPL)- The Imaging Radar Home Page

NASA's Jet Propulsion Lab (JPL)-Welcome to the Planets

NASA Observatorium:
http://physics.ship.edu/~mrc/astro/NASA_Space_Science/observe.arc.nasa.gov/nasa/core.shtml.html

Supporting Article(s):
Flying On The Ground

Pre-Lesson Instructions:

- Duplicate the Student Sheets (one per student).
- You will need to reserve a computer lab or media center before you begin this activity. If you have a large-screen monitor, this can be done as a class activity.
- If you do not have Internet access for each student, you can print out the pictures they will need on a color printer. Black-and-white pictures will take away from the power of this activity.
- Based on your resources, you can divide the class into groups of two or three students.
- If you are using the Internet, be sure to review the school's policy on Internet usage.

Background Information:

What is remote sensing? In its broadest definition, remote sensing is collecting information about an object without being in physical contact with it: learning without touching. The most familiar kind of remote sensing is the use of our eyes to detect light. Sound, heat, and X rays are other familiar examples of things that are remotely sensed. Bats sense their environment by emitting sound waves (shown in black) and listening for the reflected echo (shown in white). We learn without touching when we hear. When a car honks its horn, we can immediately tell if we are in danger or if it is just an annoyance. Animals use sound in sophisticated ways. Bats use it to find insects and to learn of their surroundings. Sound waves are used in medical imaging (ultrasound) and by ships looking for submarines (sonar). When we sit near a fire, we sense its radiant energy (heat). This is a form of remote sensing! Other animals can sense heat even better than humans. Rattlesnakes are able to detect heat radiation from small animals, like mice, with special organs on their heads. Satellites use remote sensing, too.

A satellite gathers information about something that it is not in contact with and sends that information to people on the ground. Sometimes, a satellite uses a camera to get a picture, like we would use our eyes to see. The camera is called a sensor, since that is what the satellite uses to sense, or gather, the information. Satellites can use other types of sensors, and sense things that people can't. You can see a lot of the Earth from the top of a tall building, and even more from the top of a mountain. But, there isn't always a building where you want one, and no mountain is high enough to let you see the entire Earth. This is one of the great strengths of space-based remote sensing. It allows you to put sensors in places people can't go.

- Remote-sensing pictures are used every day by:
- Archaeologists searching for ancient ruins
- Mapmakers and relief workers when there is an earthquake, flood, or volcanic eruption
- The Coast Guard, to help ships avoid icebergs
- Urban planners who need data for land-use analysis
- Geologists, to find minerals, oil, or geothermal energy sources
- Ship captains, to save fuel by following ocean currents
- Farmers, to assess insect damage
- Weather forecasters and climate researchers
- The fishing industry, to locate the best areas for fishing
- Military reconnaissance experts
- Astronomers

There are hundreds of uses for remote sensing. New ones are being developed every year. A new way of doing remote sensing that allows more mobility is the new Altair aircraft. Scientists can fly it into a storm, around a volcano, or above extremely rough terrain without ever leaving the laboratory. Today’s lesson will give students a chance to do the job of a scientist by analyzing pictures that were taken remotely by satellites.

Guidelines:

1. Read orally the 9-12 article, “Flying On The Ground.”
2. Each student or group will need a computer with Internet access.
3. The students need to go to NASA’s Observatorium Web site. See the Related Links section.

4. They should follow the instructions on the screen and begin to learn about imaging analysis.
5. Once they have finished that, there are two activities for them to do: the 1988 Yellowstone National Park Wildfires (determine the area of forests burned) and the 1993 Flooding in St. Louis, MO (determine the area of land flooded).
6. They are to make the calculations that are outlined on the Web site and record their answers on their Student Sheets. They can use the on-line calculator or their own. The Web site asks for them to input their data and submit it for approval and checking. It is optional, since they will be writing it down on paper.
7. Answers to this activity are provided on the Web site if they submit their results. Hint: if you make them submit it, it tells them if they are wrong or not. This could save you the trouble of grading it.
8. Once they repeat the first activity, they should go back and do the second one. The order in which they complete them is not important.
9. There is a chart to fill in and two questions to answer on the Student Sheets.

Discussion/Wrap-up:

- Discuss the power of remote sensing.
- Ask the students, "How else could remote sensing be used, and how will it benefit mankind?"
- Ask the students, "Does the Earth look different when viewed from space, or from a very high altitude?
- Discuss the usefulness of having a remote controlled airplane in terms of research and safety.

Extensions:

For more remote sensing images and activities, go to the NASA JPL Web sites in the Related Links section.

Remotely Sensing

Student Sheet(s)

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Materials

- Internet
- Calculator (optional)
- Color printer (optional)

Procedure

1. You will get to experience remote sensing first hand. You will be given images and asked to analyze them. Follow the instructions given on the screen. For added help, there is a practice analysis on one image that is done for you. Be sure to look it over carefully.
2. Visit NASA's Observatories Web site, listed below. http://physics.ship.edu/~mrc/astro/NASA_Space_Science/observe.arc.nasa.gov/nasa/core.shtml.html
3. Answer the first question about the image.
4. Look at the image. You may want to jot down what the colors mean for future reference.
5. If you do not know what a pixel is, click and find out. Otherwise, process the image.
6. It shows you how to determine the area shown in the picture based on the pixel size.
7. The next page has two activities: the 1988 Yellowstone National Park Wildfires and the 1993 Flooding in St. Louis, MO. Complete one of them (the order is not important), then come back and do the other.

8. Follow the instructions on the screen carefully. You can use your own calculator, or you can use the one provided in the Web site. Look at the images.
9. Fill in the boxes in this chart. Be sure to include the units used in your calculations. If your teacher wants you to, you can submit your results online to the Forestry Service or to the Relief Effort.

<table>
<tr><th colspan="2">Yellowstone Forestry Service</th><th colspan="2">St. Louis Relief Effort</th></tr>
<tr><td>Amount of forest before fires</td><td></td><td rowspan="3">Amount of area flooded</td><td rowspan="3"></td></tr>
<tr><td>Amount of forest burned</td><td></td></tr>
<tr><td>Amount of forest after fires</td><td></td></tr>
</table>

10. What are some other practical uses of remote sensing?
11. Compare the Altair's remote sensing capabilities with other means of remote sensing.

9-12 Activity #3

Materials

- Computer with Internet access

Procedure

1. Inform the class that they are going to look at some of these pictures and learn just how valuable a geography tool they can be. Divide the class into five small groups to perform in teams.

2. The interpretive skills we would like your students to explore are Color, Shapes, and Patterns. What are the observable characteristics that will help your students recognize certain natural and man-made objects and then allows them to interpret the conditions observed in these Images from Space?

   Color – Vegetation, Ocean, River, Lakes, Man-Made Objects (cities, roads, bridges)
   Shapes – Coastlines, Rivers, Lakes, Mountain Ranges, City (homes vs. work buildings)
   Patterns – Man-Made vs. Natural structures and objects.

3. This activity from EarthKAM enables the students to choose different geographical features and become familiar with what they look like in the pictures from space.
   http://www.earthkam.ucsd.edu/public/students/activities/landformations/

   The students can click through on their own or you can direct them and discuss each picture. During the event with the DLN, similar pictures will be shown and the students will be asked to identify the geographic feature.

4. Other images we would like for your students to work on before the videoconferencing event. The page will have a small thumbnail picture with a description of the picture. Click on the JPEG link to bring up a larger picture for your students to see on the computer monitor or print a hardcopy. The background information is for the teachers to see first and then you can determine how much of this information to give to your students.

   a. Earth's City Lights
      http://visibleearth.nasa.gov/view_rec.php?id=1438

   b. City Lights of Europe
      http://visibleearth.nasa.gov/view_rec.php?id=1513

   c. Chicago, IL
      http://visibleearth.nasa.gov/view_rec.php?id=11090

    d. Washington D.C. Infrared
       http://visibleearth.nasa.gov/view_rec.php?id=1366

5. Once the students have had the opportunity to look at the pictures and analyze them, query the students about what they observed in the photos. Ask questions such as:
    a. What do you think this is a picture of?
    b. Do you recognize any of the features?
    c. What questions come to mind as you look at the picture?
    d. Is there something in the picture that you want to know more about?
    e. After studying the picture, what can you tell me about it?
    f. What do you think a geographer or an early scientist looks for in a picture like this?
    g. Would this be a good place for a city? Why?
    h. Are there problems with the environment in this area?
    i. What types of geographic features are located here?