Satellites: Analyzing the Imagery
Lesson Plan

Grade Level: 6-8	**Curriculum Focus:** Technology	**Lesson Duration:** One to two class periods

Student Objectives

- Understand how satellite images are made.
- Understand that analyzing satellite images reveals features and events that may be impossible to detect otherwise.

Materials

- Discovery School video on *unitedstreaming*: *Satellite Technology*
  Search for this video by using the video title (or a portion of it) as the keyword.

  Selected clips that support this lesson plan:

  - Satellite Technology: Expanding Our Gaze, Perception, and Intelligence
  - Change Detection: Using Satellites to Analyze Earth
  - Satellite Photos: Important Visual Aides to Conservationists
  - Satellites: Eyes in the Sky

- Maps and atlases with longitude and latitude markings
- Computer with Internet access (optional but very helpful)
- 2 digital satellite images (If classroom Internet access is not available, color copies of the images may be used.):
  - Image 1: http://asterweb.jpl.nasa.gov/gallery/images/usu2.jpg
  - Image 2: http://asterweb.jpl.nasa.gov/gallery/images/college.jpg
- Pencils
- Rulers

Procedures

1. Begin the lesson by asking students if they know what the term "artificial satellite" means. Write down their ideas, and then tell them that one possible definition is "an object built by people that orbits a planet such as Earth and performs a specific task by receiving and transmitting signals." The six main types of artificial satellite are listed.

- Scientific research—used to map sea surface temperatures
- Weather—provides ongoing weather data
- Communications—used to track the satellite system
- Navigation—the Global Positioning System (GPS)
- Earth observation—used to map surface features such as land use
- Military—provides secure communications for the military

2. Ask students to describe how they think satellite images are made. Address any errors, such as the misconception that satellites film photographs that are collected and developed. Explain that satellites use remote-sensing instruments to collect data, which are transmitted from the satellite to the ground as radar or microwave signals. Some satellites have active instruments that send out a signal and record the "echo" when it bounces back to the satellite, similar to the way a submarine uses sonar to map the ocean floor. Other satellites use only passive instruments that don't emit signals, but instead collect radiation emitted or reflected from Earth.
3. Point out that raw satellite data do not make an image. The data are sets of numbers registered by digital equipment; converting them into an image requires computer software that converts ranges of radiation values into visible colors.
4. Divide the class into groups of four; tell each group they will analyze two satellite images. (If groups have Internet access, they can view the images directly on a computer monitor. If not, each group should have color copies of the images.) Given students the following information about each image, but have them complete/answer the numbered questions. (Correct answers are given in brackets). Tell students that their goal is to work together.

Image 1: Volcanic Eruption

Link: http://asterweb.jpl.nasa.gov/gallery/images/usu2.jpg

Date: April 3, 2000

Location: latitude 42.53° N, longitude 140.83° E

Instrument wavelength: Infrared

Image coverage: 18 by 22 km (13 by 15 mi)

Satellite: TERRA (instrument: ASTER - Advanced Spaceborne Thermal Emission and Reflection Radiometer)

Orbit type: Polar

Credit: NASA/GSFC/MITI/ERSDAC/JAROS, and U.S./Japan ASTER Science Team

(1.) Country: [Japan]

(2.) Name of volcano: [Mt. Usu]

(3.) What is the largest feature in this image? [Lake Toya]

(4.) What might the three dark streaks in the image be? What could have caused them? [Ash deposits from the eruption of Mt. Usu]

(5.) How might this region look in an image taken six months later? [The ash trails will no longer be visible. Some snow will remain. If the volcano erupts again, it may create more ash plumes, and the crater may widen.]

Image 1: Volcanic Eruption

Link: http://asterweb.jpl.nasa.gov/gallery/images/college.jpg

Date: June 24, 2000

Location: latitude 61° 15' 25" N, longitude 147° 37' 12" W

Instrument wavelength: Infrared

Image coverage: 20 by 24 km (12 by 15 mi)

Satellite: TERRA (instrument: ASTER)

Orbit type: Polar

Credit: NASA/GSFC/MITI/ERSDAC/JAROS,and U.S./Japan ASTER Science Team

(1.) Country: [U.S.]

(2.) This image covers a portion of a fjord, a narrow inlet with steep cliffs. What is the name of the fjord? [College Fjord, Alaska]

(3.) This image clearly shows two prominent glaciers. Harvard Glacier is the large one on the left; Yale is on the right. Snow and ice appear white and blue, and water appears dark because it reflects the least amount of infrared energy. Examine the areas where the glaciers touch the water. Which one appears to be shrinking and which one is growing into the fjord? [Harvard Glacier is growing; the boundary between glacier and water is well defined and appears to have some accumulation. Yale Glacier is receding; vegetation appears to be growing in areas scraped by the glacier.]

(4.) Icebergs that have broken away from glaciers can be seen as white dots in the water. Which glacier appears to be producing the most icebergs? [Harvard Glacier]

(5.) Where are the largest concentrations of vegetation (shown in red)? [Along the fjord walls]

5. After students have completed their analyses, have a class discussion on the results. Have representatives from each group share their results and explain how they reached their conclusions.

6. Assign the following homework assignment:

Track major weather conditions for five days using satellite images from television and newspaper reports or online at http://weather.com. You will be able to identify major patterns and possibly forecast weather events.

(1.) Choose a region (example: the southeastern U. S.). Trace a map of this region. Make a total of five copies.

(2.) Each day find a weather satellite image of this region. (Each one should be from about the same time of day.)

(3.) Draw cloud patterns from the satellite images each day. If you can determine directions of movement, draw arrows indicating where they should go.

(4.) After five days, look at your maps. Write a paragraph describing how cloud-cover patterns change.

Assessment

Use the following three-point rubric to evaluate students' work during this lesson.

- **3 points:** All questions answered thoroughly; group displayed cooperation and communicated effectively.
- **2 points:** Most questions answered; group was somewhat effective at cooperating and communicating with each other.
- **1 point:** At most, half the questions were answered; group cooperation and communication was somewhat ineffective.

Vocabulary

equatorial
Definition: Being in the plane of the Equator
Context: Satellites in an equatorial orbit take only 90 minutes to move around Earth.

geosychronous
Definition: An orbit requiring a velocity so that a satellite appears to stay in a fixed position
Context: The orbital period of a satellite in geosynchronous orbit is 24 hours.

infrared
Definition: Radiation with energy lower than that of visible light; just beyond red in the spectrum
Context: SeaWiFS satellites measure infrared energy that provides sea-surface temperatures.

orbital period
Definition: The amount of time it takes a satellite to travel around a planet
Context: A satellite's orbital period can be adjusted by changing its altitude.

polar orbit
Definition: Passing over a planet's North and South Poles
Context: A satellite with a polar orbit will cover the entire Earth.

remote sensing
Definition: The act of detecting objects from a distance
Context: Satellite remote-sensing instruments track ozone levels in the upper atmosphere.

Academic Standards

National Academy of Sciences

The National Science Education Standards provide guidelines for teaching science as well as a coherent vision of what it means to be scientifically literate for students in grades K-12. To view the standards, visit http://books.nap.edu.

This lesson plan addresses the following science standards:

- Earth and Space Science: Earth in the solar system
- Science and Technology: Understandings about science and technology

Mid-continent Research for Education and Learning (McREL)

McREL's Content Knowledge: A Compendium of Standards and Benchmarks for K-12 Education addresses 14 content areas. To view the standards and benchmarks, visit link: http://www.mcrel.org/compendium/browse.asp

This lesson plan addresses the following national standards:

- Science—Earth and Space Sciences: Understands the composition and structure of the universe and the Earth's place in it
- Language Arts—Reading: Uses reading skills and strategies to understand and interpret a variety of informational texts
- Technology— Understands the nature and uses of different forms of technology

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Support Materials

Develop custom worksheets, educational puzzles, online quizzes, and more with the free teaching tools offered on the Discoveryschool.com Web site. Create and print support materials, or save them to a Custom Classroom account for future use. To learn more, visit

- http://school.discovery.com/teachingtools/teachingtools.html