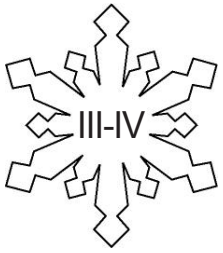
Sea Ice and Satellites

Levels



Grades 5-8

Overview:

Students explore satellites: what they are, how they work, how they are used, and how to interpret satellite images of sea ice using Google Earth. (NOTE: This lesson may require more than one class period.)

Objectives:

The student will:

- use Google Earth to examine satellite images;
- identify how satellites stay in orbit;
- determine how satellites are used; and
- use satellite images to analyze sea ice.

Materials:

- Metal washer
- 3-foot long string
- Globe
- Computer with Internet access
- Google Earth (see Activity Preparation)
- OVERHEAD: “Satellites”
- OVERHEAD: “Gravity and Momentum”
- STUDENT WORKSHEET: “Sea Ice and Satellites”

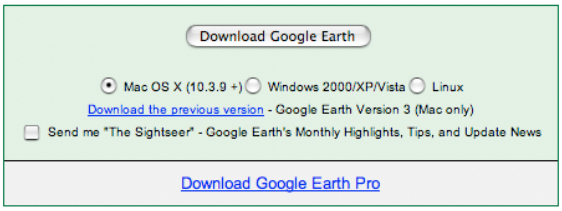
GLEs Addressed:

Science

- [5-8] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.
- [6] SE2.1 The student demonstrates an understanding that solving problems involves different ways of thinking by identifying and designing a solution to a problem.
- [6] SD4.1 The student demonstrates an understanding of the theories regarding the origin and evolution of the universe by contrasting characteristics of planets and stars (i.e., light reflecting, light emitting, orbiting, orbited, composition).
- [8] SD3.2 The student demonstrates an understanding of cycles influenced by energy from the sun and by Earth’s position and motion in our solar system by recognizing types of energy transfer (convection, conduction, and radiation) and how they affect weather.

Activity Preparation:

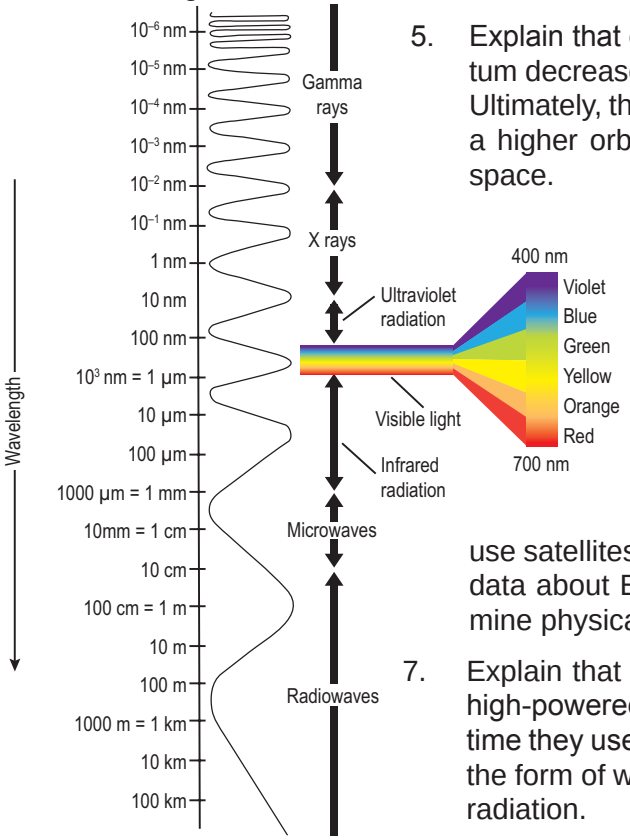
1. This activity requires Google Earth be installed on a computer with Internet access. If Google Earth is not already installed on an available computer, follow the steps below.
   a. Navigate to http://earth.google.com/download-earth.html.
   b. In the Download Google Earth dialog box, click a radio button to choose the appropriate version.
   c. Click on Download Google Earth to begin the download.
   d. If the Google Earth installer does not automatically load after the download has completed, double-click on the Google Earth dmg file to start the installer. Follow the instructions.



2. Navigate to the NSIDC Data on Virtual Globes site (http://nsidc.org/data/virtual_globes/). Click on the link "Snow, ice, glaciers, and permafrost file for Google Earth" to download the file. Place the file in an easy to retrieve location for later use.

Activity Procedure:

1. Ask students if they know what satellites are and what purpose they serve. If necessary, explain that a satellite is any object that orbits another object. Earth is a satellite around the sun. The moon is a satellite around Earth.
2. Explain that people have put artificial satellites into space that orbit around Earth. Many of these satellites are low enough to be seen by the human eye at night. They look like stars that move across the sky, but do not streak, like a comet would. Show OVERHEAD: "Satellites" and explain satellites are used in many different ways, such as communications, navigations, remote sensing, reconnaissance, and astronomy.
3. Ask students if they know how a satellite stays in orbit around Earth. Show OVERHEAD: "Gravity and Momentum." Explain that gravity and the momentum of the satellite work together to keep the satellite in orbit.
4. Complete the following demonstration. Tie a 3-foot long piece of string to a washer. Hold the other end of the string and whirl the washer over your head. Explain that the washer is held in its orbit around your head by the string. A satellite is held close to Earth by gravity, just as we are held close to the ground. The swinging motion causes the forward motion of the washer, its momentum. If the "gravity" of the string were not acting on the washer, it would continue in one direction. When the momentum of a satellite and the gravity acting upon it are equal, the satellite remains in orbit without falling towards or away from Earth. Rockets control the forward motion of a satellite. Once the rockets are turned off, inertia keeps the satellite going in one direction. If it is safe, let go of the string to show how the satellite would continue in one direction if gravity was not acting on it, or if its momentum was too strong.



5. Explain that eventually all satellites will stop working. As their momentum decreases, gravity will cause the satellites in low orbit to descend. Ultimately, they will burn up in Earth's atmosphere. Satellites that are in a higher orbit will be moved to a less desirable orbit and remain in space.

Critical Thinking Question:
Think-Pair-Share Method. Ask students to pair up and talk about the following: why are satellites not brought back to Earth? (*cost*); what will happen if satellites stay in space forever?; and what can be done to solve the problem? Once they have explored the questions, ask students to share their ideas with the class.

6. Remind students that scientists and businesses use satellites to send signals for televisions and cell phones, to collect data about Earth's environment, to study weather patterns, to determine physical location, and many other things.
7. Explain that satellites that study Earth's environment sometimes use high-powered cameras to take photographs. However, most of the time they use electromagnetic radiation instead. Radiation is energy in the form of waves. Microwaves, radio waves, and light all are forms of radiation.

8. Explain that the wavelength of a particular type of radiation determines what our eye can see. The colors that we see have wavelengths of approximately 400nm (nanometers, or one millionth of a meter) to 700nm.

9. Explain that all objects give off radiation. The temperature of an object affects the amount and type of radiation it gives off. Satellites receive radiation through a device called a radiometer.

10. There are two kinds of radiometers: imagers and sounders. Imagers measure the amount of visible light from the sun that is reflected back to space by Earth's surface or by clouds; and the amount of radiation emitted by Earth's surface and clouds.

11. Sounder is short for Vertical Atmospheric Sounder (VAS). Sounders measure infrared radiation and provide profiles of temperature, pressure, water vapor, and trace gases, such as carbon dioxide, in Earth's atmosphere. These types of satellites are used to forecast weather.

12. Data from imagers is transmitted to Earth where computers produce visible and infrared images. Visible images are what we see what our naked eye and require daylight. Infrared images are based on the amount of radiation an object emits.

13. Radiometers can provide information about Earth and our atmosphere using visible, infrared, and microwave regions of the electromagnetic spectrum. The types of satellites that use microwave radiation are called SAR, synthetic aperture radar. The shorter wavelength of the microwave, unlike infrared and visible light, can penetrate clouds, haze, smoke, rain, and snow in the atmosphere, meaning that SAR satellites don't need clear skies to produce images. In fact, SAR satellites can produce images day or night.

14. Scientists studying weather patterns aren't interested in microwave radiometers and SAR satellites because they want to see the clouds; but those types of satellites are very valuable to scientists studying sea ice. Sea ice and sea water emit microwave radiation in addition to visible light radiation. Sea ice emits a much greater amount of microwave radiation than water, so it is easy for a microwave radiometer to tell them apart.

15. Once the satellite receives the data, it is processed into an image. One place to see images of sea ice is through Google Earth. Distribute the STUDENT WORKSHEET: "Sea Ice and Satellites."

Teacher's Note: The Google Earth section of this lesson can be done as a whole class, in small groups, or individually depending upon student computer literacy and computer availability.

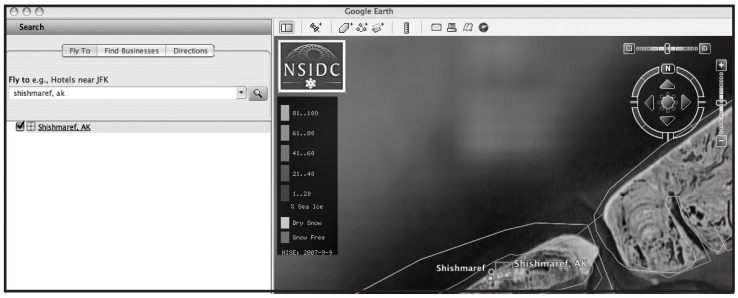
---

16. Double-click the NSIDC_Google Earth.kmz file (downloaded during Activity Preparation) to open. Zoom in or out using the scroll button on the mouse or the zoom function in the upper right hand corner of the screen to center on the North Pole.

17. Show students a globe and ask them to point out the countries they see on Google Earth. Point out the yellow lines on Google Earth showing the border between countries. If the yellow lines are not visible, click on "borders" in the layers sidebar.

18. Point out the key in the upper corner of the screen that shows the percentage of sea ice on the image. The areas of light blue are 81-100% covered in sea ice. The darkest blue is open ocean. White areas are covered in snow.

19. Ask students to find their community on the map by typing the community name in the "Fly To" dialog and hitting [RETURN] or clicking the magnifying glass.



20. Make sure the status bar is visible by going to the View menu and verifying that “Status Bar” is checked. Point out the “Eye alt,” or the eye altitude (the height above the ground). Zoom out to approximately 60 km using the zoom tool in the upper right corner or the scroll button on the mouse.

21. Can sea ice be seen on the shore of the community? If not, zoom out until sea ice is visible and use the ruler tool to determine how far the community is from sea ice.

    a. Click on show ruler on the toolbar at the top of the window.

    b. Click on the gray box at the community name, and then click again on the sea ice edge.

    c. The ruler dialog will show the distance between the two points. Change the units by clicking on the drop-down menu and selecting kilometers.

    d. Close the ruler.

22. Show students that by clicking and dragging they can pan across the image. Zoom out and/or pan south until the furthest edge of sea ice is visible.

23. Point out that the latitude and longitude of the pointer is visible at the bottom of the screen. Move the pointer until it is over the southern most portion of sea ice. Ask students to identify the latitude and longitude of that point.

24. Show students how they can turn on or off the names of populated places on the map. Go to the layers sidebar on the left side of the screen. If the sidebar is not showing, click on “Sidebar” in the View menu. Click on the box next to “Populated Places” to turn the feature on.

25. Move the mouse over the gray circles to show the names of communities. Ask students to identify the names of the communities in Alaska closest to the southern most sea ice. Ask students to identify the percentage of sea ice present in that region.

26. Ask students to name the countries in the Northern Hemisphere that have sea ice on their coastline. Allow use of the globe to identify country names.

Extension Idea: Ask students to build their own satellite and write a mission for it. Before they build their satellites, ask students to draw a blueprint of their satellite, and determine how their satellite will be powered, what mission it will accomplish, and what kind of equipment it will need to accomplish that goal. Provide students with pictures of satellites and various materials, such as cans, egg cartons, paper or foam cups, etc. to build their satellites. When they are finished, ask students to draw another blueprint of the completed satellite and reflect on the changes from the original idea to the final product.

Answers:

STEP 1 through STEP 7: Answers will vary.

Further Questions:

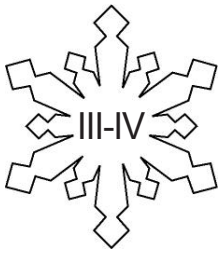
1. A. gravity and momentum
2. Answers will vary; acceptable answers include: astronomy, communication, navigation, reconnaissance, remote sensing, and derivations thereof
3. D. radiometers

Name:_____

Sea Ice and Satellites

Student Worksheet

Levels



Directions: Use the following steps to answer the questions regarding sea ice near your community.

STEP 1. Use the "Fly To" feature of Google Earth to navigate to your community.

STEP 2. Zoom out until sea ice can be seen. What is the eye altitude (eye alt) of the image?

_____ km

STEP 3. Use the ruler tool to measure the distance from the shore to the edge of the sea ice.

_____ km

STEP 4. Pan and zoom to find the southern most area of sea ice in Alaska. What latitude and longitude is the southern most sea ice?

_____ ˚N _____ ˚W

STEP 5. What community is closest to that sea ice floe? _____

STEP 6. What percentage of sea ice is present in that region? (Hint: Use the NSIDC Key) _____%

STEP 7. Zoom out. What countries in the Northern Hemisphere have sea ice bordering them? If needed, look at a globe to identify country names. _____

_____

Further Questions:

Directions: Answer the following questions.

1. What keeps a satellite in orbit around Earth?
   - A. gravity and momentum
   - B. gravity and speed
   - C. weight and momentum
   - D. weight and speed

2. Name three ways that satellites are used.

   _____

   _____

   _____

3. Satellites receive radiation through:
   - A. thermometers
   - B. computers
   - C. cameras
   - D. radiometers