

# Snow Cover and Satellites *(modified for ADEED)*

## Overview:

Students explore satellites: what they are, how they work, how they are used, and how to interpret satellite images of snow cover 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 global snow distribution.

## 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] SB4.2 The student demonstrates an understanding of motions, forces, their characteristics, relationships, and effects by stating that every object exerts gravitational force on every other object.
- [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).
- [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.
- [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

## 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: "Snow and Satellites"

## Whole Picture:

Satellite images of Earth are available through a wide variety of online sources. *Google Earth* is free, downloadable software that allows people to view a virtual globe of Earth, where map and geographic information is presented. *Google Earth* includes images of various resolutions obtained from satellite imagery and aerial photography. Several organizations, including the National Snow and Ice Data Center, make satellite imagery of sea ice and snow available in *Google Earth* format for easy viewing.

Satellites that study Earth's environment sometimes use high-powered cameras to take photographs, however, many of them use electromagnetic radiation instead. Radiation is energy in the form of waves and is naturally occurring; all objects emit radiation waves. Microwaves, radio waves, and light

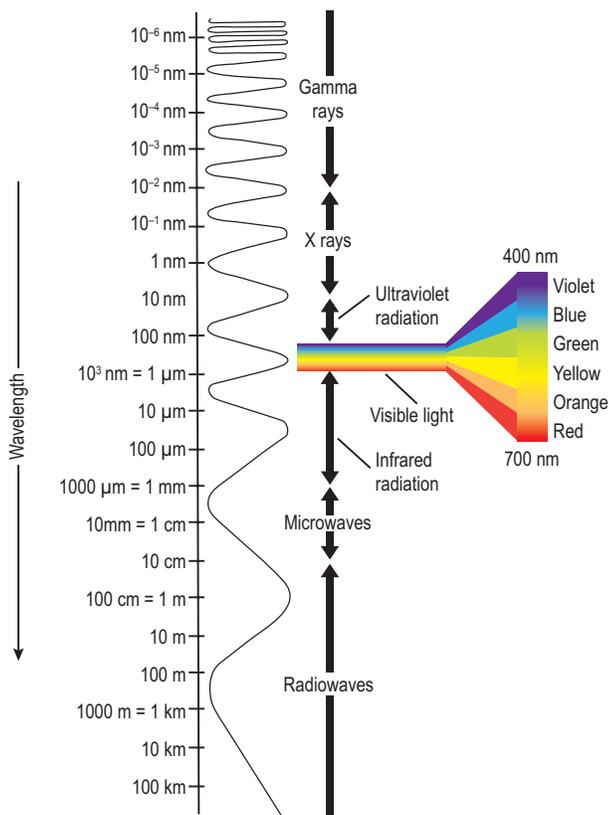
are all forms of radiation. The temperature of an object affects the amount and type of radiation it gives off. Satellites receive the radiation emitted by Earth with a device called a radiometer. Because sea ice, open water, and land give off vastly different amounts of radiation, satellites that use radiometers can easily detect the different between the three, making these satellites much more useful to sea ice scientists than camera-based satellites.

## Activity Preparation:

- 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.
  - Navigate to <http://earth.google.com/download-earth.html>.
  - In the Download *Google Earth* dialog box, click a radio button to choose the appropriate version.
  - Click on **Download Google Earth** to begin the download.
  - 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.
- Navigate to the NSIDC Data on Virtual Globes site ([http://nsidc.org/data/virtual\\_globes/](http://nsidc.org/data/virtual_globes/)). Click on the link "**Snow (MODIS) Sensor 2008 snow cover**" to download the file. Place the file in an easy to retrieve location for later use.

## Activity Procedure:

- 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.
- 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.



- 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.
- 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. Gravity affects all things. 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.

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**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.

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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 with 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: "Snow and Satellites."

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**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.

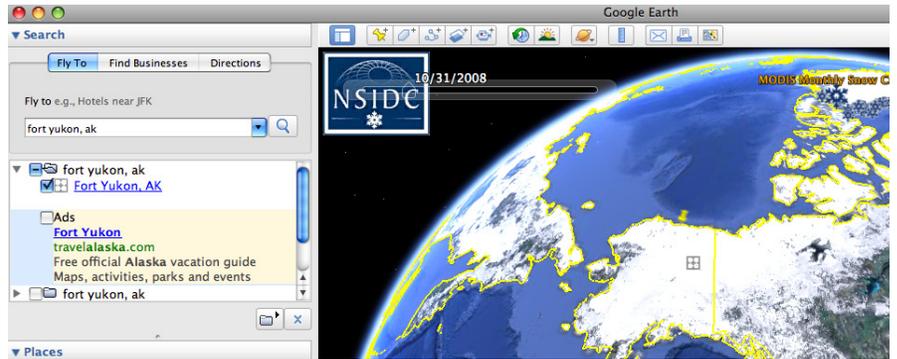
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16. Double-click the **NSIDC\_Google Earth.kmz** file (downloaded during Activity Preparation) to open. Zoom in or out using the scroll button on the mouse or the zoom function in the upper right hand corner of the screen to center on the North Pole.

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 lower corner of the screen that shows the percentage of snow cover on the image.

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 6,000 kilometers using the zoom tool in the upper right corner or the scroll button on the mouse.

21. Move the time selector on the top left of the screen to March 21st, the first day of spring. Zoom out until snow is not visible and use the ruler tool to determine how far the community is from a snow free area.

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 snow cover 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 snow cover 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 snow cover. 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. Adjust the time slider to June 1st. 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 remaining snow cover. Ask students to identify the percentage of snow cover present in that region.

26. Ask students to name the countries in the Northern Hemisphere that are fully covered by snow in winter months. 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.

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## 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

# Satellites

## Overhead

Astronomy Satellites  
Study the stars.



Hubble Space Telescope, launched by NASA in April 1990

Communication Satellites  
Transmit radio, television, and telephone transmissions.



Anik E, launched by Canada in 1972

Reconnaissance Satellites  
Spy on other countries and detect missile launches.

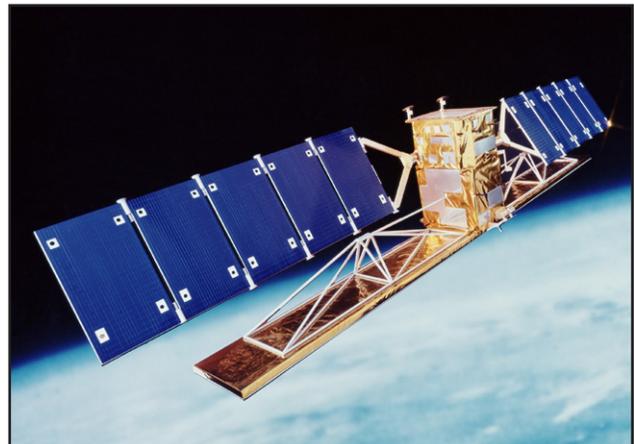


Navigation Satellites  
Find a position on Earth.

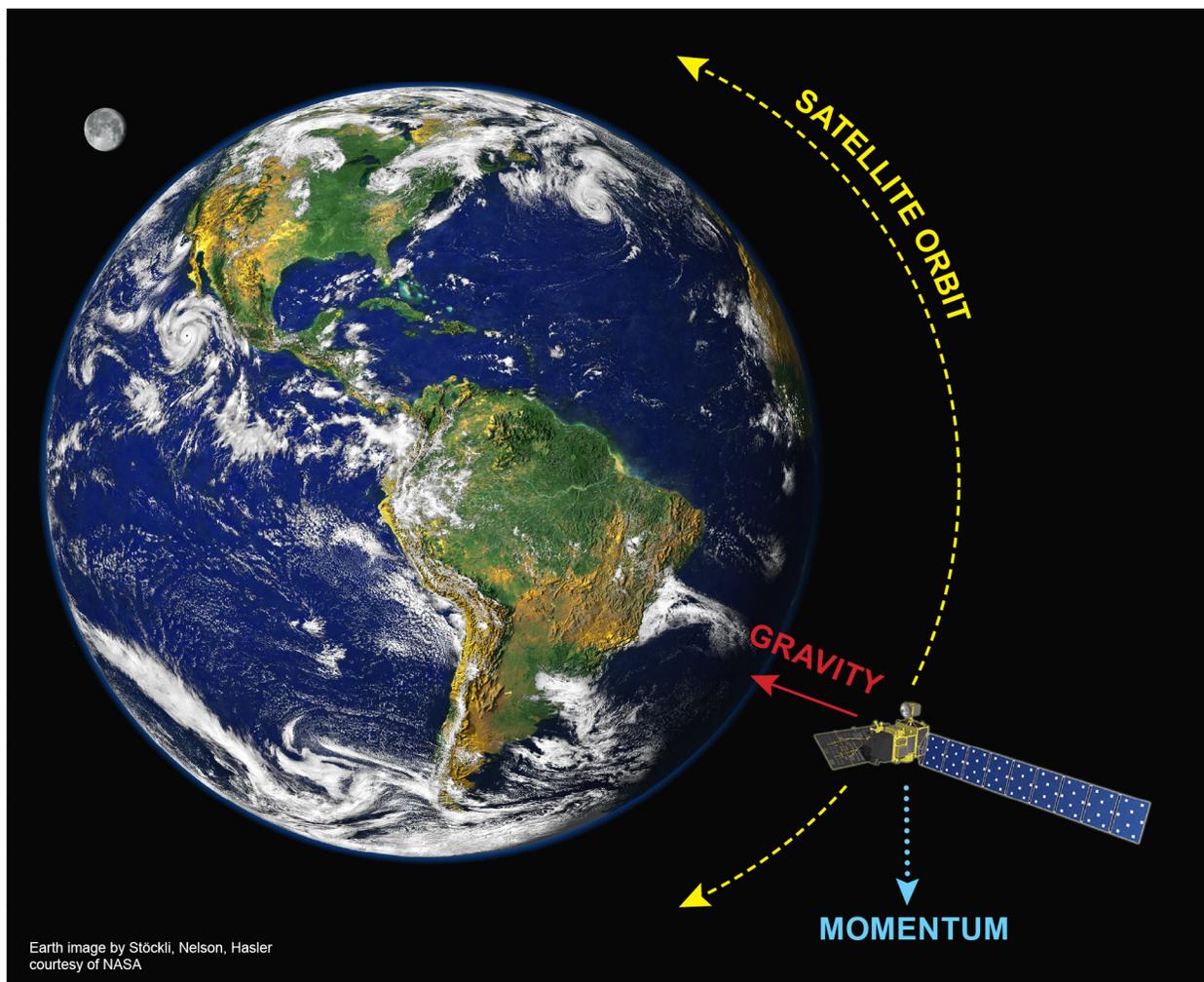


Navstar, launched by the United States Department of Defense in 1978

Remote Sensing Satellites  
Observe and measure Earth's systems.



# Gravity and Momentum Overhead



Name: \_\_\_\_\_

# Snow Cover and Satellites

## Student Worksheet

**Directions:** Use the following steps to answer the questions regarding snow cover near your community.

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

STEP 2. Move the time selector to March 21st. Zoom out until a snow free area 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 your community to a snow free area.

\_\_\_\_\_ km

STEP 4. Pan and zoom to find the southern most snow free area in Alaska. What latitude and longitude is the southern most snow free area?

\_\_\_\_\_ °N \_\_\_\_\_ °W

STEP 5. What community is closest to that area? \_\_\_\_\_

STEP 6. What percentage of snow cover is present in that region? (Hint: Use the NSIDC Key) \_\_\_\_\_%

STEP 7. Zoom out. What countries in the Northern Hemisphere have 100 percent snow cover in winter? 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

C. weight and momentum

B. gravity and speed

D. weight and speed

2. Name three ways that satellites are used.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

3. Satellites receive radiation through:

A. thermometers

C. cameras

B. computers

D. radiometers