Weather Satellites

Lesson 2 of 2

Grade Level: 9-12
Subjects: Earth Science, Physical Science
Prep Time: 30 minutes
Activity Duration: 50-minute period
Materials Category: Special requirements

National Education Standards				
Science	Mathematics	Technology		Geography
		ISTE	ITEA	
3b, 5a, 5b				

Objective:

To learn and understand how different types of weather satellites are used to help forecast the weather.

Materials:

- Transparency of weather satellite images
- Volleyball or soft football
- Battery-operated toy that emits a constant sound

Related Link:

The National Climatic Data Center's
http://www.ncdc.noaa.gov

Weather Satellites

Teacher Sheets

Pre-lesson Instructions

Make a transparency of a satellite image. Images can be found at The National Climatic Data Center web site (http://www.ncdc.noaa.gov).

Guidelines

1. Read the NASAexplores 9-12 article, "Weathering the Storm." Discuss how weather impacts traveling.

2. Ask students, "What are some ways satellites are used by the world?" (viewing Mt. St. Helens and Chernobyl disasters, spying, communications, vegetation monitoring, etc)

3. Hand out Student Sheets. Give students time to read and answer the questions.

4. Show students the satellite transparency. See if students can identify the thickest clouds (solid white). Where are skies partly cloudy? (where you see only bits of white) Where are there cirrus clouds looking as if they were painted with a brush? (Answers will vary.) See if students can find the counterclockwise circulation of clouds around the low-pressure areas.

5. Explain the Doppler Radar Detection System by using a volleyball and a battery-operated toy, which emits a constant sound. Cut a hole in the ball and insert the toy or horn. Demonstrate how the sound is constant. But, as students toss the ball across the room, ask they what happens to the sound? *(the pitch changes*) Ask them how the sound changes? (*changes as ball approaches and leaves)* Why? *(change in frequency)* Point out that the Doppler Radar Detection System can detect wind patterns within a storm to tell if a tornado is developing. Doppler radar calculates wind by detecting particles moving either toward or away from the radar. Ask how it can tell how a particle is moving. (*by the change in the radar signal)* The echo from a particle moving away from the radar is different from an echo from a particle moving toward the radar.

6. Allow students time to view radar pictures via the Internet to plot incoming storms, rain, or snow on their weather map. Identify which areas have more precipitation, heavier precipitation. Observe how the echoes are moving to detect storms if any. Plot and graph data on a weather map.

Extension

- Research the history of the Doppler radar.

Weather Satellites

Student Sheet(s)

Background

Weather satellites are spacecraft that collect and relay weather information to Earth. Before the first weather satellite was launched in 1960, forecasters could not reliably track weather across the oceans that cover most of the Earth.

There are two types of weather satellites. *Polar orbiting satellites* circle the Earth from pole to pole, competing one orbit every 100 minutes. These satellites orbit at an altitude of about 500 miles above the Earth's surface and provide coverage of the entire Earth four times per day.

The second type of weather satellite is the *geostationary*. Geostationary satellites orbit the Earth at the same rate that the earth rotates, so the satellite is always seeing the same part of Earth. Geostationary satellites provide continuous viewing of the United States and adjacent coastal waters from their vantage points over the equator. Since geostationary satellites rotate at the same rate as Earth, they complete one orbit every 24 hours. Geostationary satellites are located at a much higher altitude than polar orbiting satellites, positioned at 22,300 miles above the Earth's surface. Under normal operating conditions, two satellites observe the Eastern and Western United States, adjacent oceans, and a large part of the Southern Hemisphere. Image data collected by all satellites are transmitted down to computers on Earth, which transform the data into the images that can seen on the television weather broadcast.

Satellites can provide an image of the weather day or night by infrared images. An infrared satellite image, taken day or night, shows the pattern of heat (or infrared radiation) released from the Earth. Chances are, images seen on the late evening television weather broadcast are infrared images. The Earth radiates heat into space all the time. Infrared imagery shows different temperatures in black, white, and shades of grey. The coldest temperatures show up as white and the warmest as black. Since the tops of high clouds are very cold, those clouds show up on the infrared image as white. Lower clouds in the atmosphere are warmer, so they show up as a darker shade of grey on the infrared image.

An echo results when a transmitted sound or signal bounces off of an object and returns to the original transmitter. This concept is very important in the detection of rain and snow with a special tool called RADAR (Radio Detection and Ranging). Radar is a radio transmitter that sends out a signal that bounces off of rain and snow. (Weather radar does not detect clouds.) The radar signal is transmitted by a rotation dish antenna mounted on a tower. As the dish rotates in all directions, it sends signals that quickly bounce off of precipitation within a cloud. If the radar receives a precipitation echo, it places the echo on the radar screen (or slope) by calculating how long it took the precipitation echo to

return, the radar tells the meteorologist how far the precipitation is from the station. The meteorologist can track the storm on the radar scope to determine how a storm is moving.

The line sweeping around the radar screen represents the radar antenna rotating in all directions. The heavier the precipitation, the stronger the echo. Weather radar can detect six different intensities of precipitation, assigning a color to each. Although the colors can vary from station to station, the lightest precipitation is usually blue and green, with the heaviest precipitation yellow and red. These colors tell a meteorologist how much rain could fall on an area in 1 hour.

Doppler Radar detects precipitation and wind circulation within a cloud. Doppler radar calculates wind by detecting particles moving either toward or away from the radar. It tells how a particle is moving by the change in the radar signal. The echo from a particle moving away from the radar is different than an echo from a particle moving toward the radar. The radar determines this and indicates how the particle moves in the cloud.

Questions

1. Define weather satellite.
2. Explain the importance of weather satellites to forecasting.
3. Describe how the two different weather satellites are used to forecast weather.
4. Explain how a satellite image is taken.
5. Describe an infrared satellite image.
6. Identify the colors on the radar.
7. Explain how Doppler radar works.