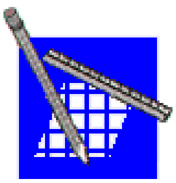
Question: How are infrared satellite images used to observe global weather patterns?

Materials: Science on a Sphere™ globe with infrared satellite data sets, calculators (one for each student), colored temperature scale used for infrared images (one for each student), two laser pointers with different shaped points, tape measure, paper (provided), and pencil



Procedure

Preliminary

(Tell students...We, the observers, see this model as a satellite sees the Earth in space. In other words, we are like a geostationary satellite, remaining over the same location on Earth as we watch the weather passing beneath us. We are observing a global infrared (heat) image. Because Earth and its atmosphere emit heat both day and night, infrared images are providing round-the-clock temperature information for the top of the features that it observes.)

Primary - Part A

Use the Science on a Sphere™ model globe to determine how far from Earth a satellite must be in order to view the Earth's full disk in a geostationary orbit. The Sphere measures six feet in diameter. The Earth's diameter is approximately 8000 miles.

1. Use a tape measure to find the distance (English units) from the lens of one projector to the center of the sphere.

2. Use the following formula (ratio and proportion) to calculate the distance between a satellite and the center of the Earth. Use the worksheet at the end of this lesson to show your calculations and answer.

$$\frac{\text{Radius of the Sphere}}{\text{Distance from Projector to the Center of Sphere}} = \frac{\text{Radius of the Earth}}{\text{Distance from Satellite to the Center of Earth}}$$

3. Find the difference between the "Distance from the satellite to the center of Earth" and the radius of the Earth. The result is the distance that a satellite must be from Earth in order to view the Earth's full disk.

◆ Note: Use the worksheet handed out to you at the beginning of this lesson to do the calculations required for Part A. Show your work. A sample of this worksheet is included on Page 4-5 at the end of this lesson.

Primary - Part B

(Instruct students to sit in two rows, perpendicular to, and facing North and South America and the Atlantic Ocean on the Sphere.)

This is a game of "I See". First, hand out the colored temperature scale. An example of the scale is shown in Figure L4.1.

Now ask students to look for patterns made by the infrared images. Have the first two students in each row stand up; hand them each a laser pointer. The teacher says "I see…" (then, name one of the features listed as follows). The first student whose pointer touches the correct location and follows it through part of the rotation in view gets the point for his or her team.

As the first two students who played move to the back of their rows, the next two students prepare to repeat the process. Practice once or twice before beginning the game. Repeat "I see" for sites that you want students to remember.

Characteristics to be identified (add any other interesting features).

1. An area with no clouds
2. An area with high clouds (thin, wispy)
3. Clouds breaking apart
4. An area with middle clouds
5. An area with the warmest temperature
6. An area with the coldest temperature
7. Winds moving east to west in the Northern Hemisphere (trade winds)
8. Winds moving west to east in the Northern Hemisphere (prevailing westerlies)
9. Highest clouds
10. Locate a storm in the Northern Hemisphere (counterclockwise rotating air mass)
11. Locate a storm in the Southern Hemisphere (clockwise rotating air mass)
12. Locate a weather front (line of moving clouds)

13. Locate a high pressure area in the Northern Hemisphere (clockwise rotating air mass)
14. Locate a high pressure area in the Southern Hemisphere (counterclockwise rotating air mass)
15. Locate the intertropical convergence zone [ITCZ] (line of moving clouds just north of the equator)
16. Locate a cloud where rain is probably falling beneath (temperature under -35 Degrees Celsius)

Figure L4.1. Temperature Color Scale for Infrared Images (Individual Copies will be Passed Out to Students for Lesson)

Primary - Part C

(Instruct students to sit in two rows, perpendicular to, and facing North and South America and the Pacific Ocean on the Sphere.)

This also is a game of "I See"...the same as "Procedure - Primary - Part B"...except using the Pacific Ocean Basin and Rim instead of the Atlantic.

The techniques are the same and the characteristics to be identified are the same as well.

Don't forget to add any other interesting features as you see fit.

Questions

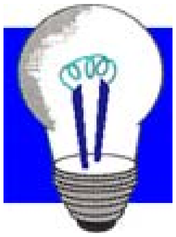
(Ask students the following questions and help them to answer correctly.)

1. How well can we tell whether it is daytime or nighttime using infrared images?

2. Hurricanes begin forming off the coast of Africa and gain power from evaporating water as they cross the warm waters of the Atlantic on their way to the Caribbean Sea and Gulf of Mexico.

   Based on this information, in what season was this infrared satellite image probably observed?

3. What might you infer about the weather, and possibly the climate and amount of vegetation, in areas where there is a concentration of cloud cover?



Conclusion

(Ask students to answer the question stated at the beginning.)

Infrared satellite sensors measure the temperature for the top of an area that it observes. From this information, you can identify clouds, ground temperature in cloudless areas, storms, and wind patterns as clouds move.

Answer Key

For "Procedure - Part A"

The satellite must be approximately 22,000 - 23,000 miles from Earth's surface.

For "Procedure - Part C"

1. There are more dark colors (dark gray and black) that indicate warmer temperatures, therefore - warmer daytime temperatures.

2. Summer or fall - because hurricanes occur during these two seasons.

3. Higher clouds mean a greater likelihood of rain beneath the clouds. Higher concentrations of clouds might indicate more persistent rain, and therefore greater plant growth.

Les 4-4

FYI

Science on a Sphere ™

Lesson 4 - Earth's Atmosphere Viewed from Space
Student Worksheet for "Procedure - Primary - Part A"

Use the Science on a Sphere™ model globe to determine how far from Earth a satellite must be in order to view the Earth's full disk in a geostationary orbit. The Sphere measures five feet in diameter. The Earth's diameter is approximately 8000 miles. Record all your measurements and show all your work below.

1. Use a tape measure to find the distance (English units) from the lens of one projector to the center of the sphere.

2. Use the following formula (ratio and proportion) to calculate the distance between a satellite and the center of the Earth.

$$\frac{\text{Radius of the Sphere}}{\text{Distance from Projector to the Center of Sphere}} = \frac{\text{Radius of the Earth}}{\text{Distance from Satellite to the Center of Earth}}$$

3. Find the difference between the "Distance from Satellite to the Center of Earth" and the "Radius of the Earth". The result is the distance that a satellite must be from Earth in order to view the Earth's full disk.

Answer:______________________________________

Les 4-5