III. Images of the Atmosphere

Learning Objectives

Students will:

- Compare and contrast images of the atmosphere
- Learn about how different graphic displays can be used to share information about the same thing

Estimated Time:

30 minutes

Materials:

- Samples of common images (http://www.weather.gov/sat_tab.php?image=vis)
- Set of Comparison Images of Hurricane (Overhead Images 1, 2, and 3; CALIPSO image)

Vocabulary:

- **Satellites**- something that is in orbit around something else. For example, the Moon is a natural satellite in orbit around the Earth. Terra and Aqua are artificial satellites put into Earth orbit. The Mars Reconnaissance Orbiter is an artificial satellite put into orbit around Mars (http://science.nasa.gov/realtime/ Satellite tracking site)
- **Remote sensing**- Obtaining information about a subject, as with a camera, without being in contact with it. This term is now commonly used in conjunction with electromagnetic techniques for acquiring information. That is, techniques which image part of the electromagnetic spectrum (i.e., visible light, infrared energy (heat), X-rays, ultraviolet light, etc...).
- **Hurricane**- a giant swirling storm characterized by a low-pressure center and numerous thunderstorms that produce strong winds and flooding rain.
- **Weather**- The state of the atmosphere at a particular place and time. Weather includes variables such as temperature, atmospheric pressure, wind, cloudiness, precipitation, and relative humidity.
- **Atmosphere**- the mixture of gases that surrounds the Earth and some other planets. The concentrations of the gaseous constituents of Earth's atmosphere are determined by biogeochemical processes, including manmade effects.

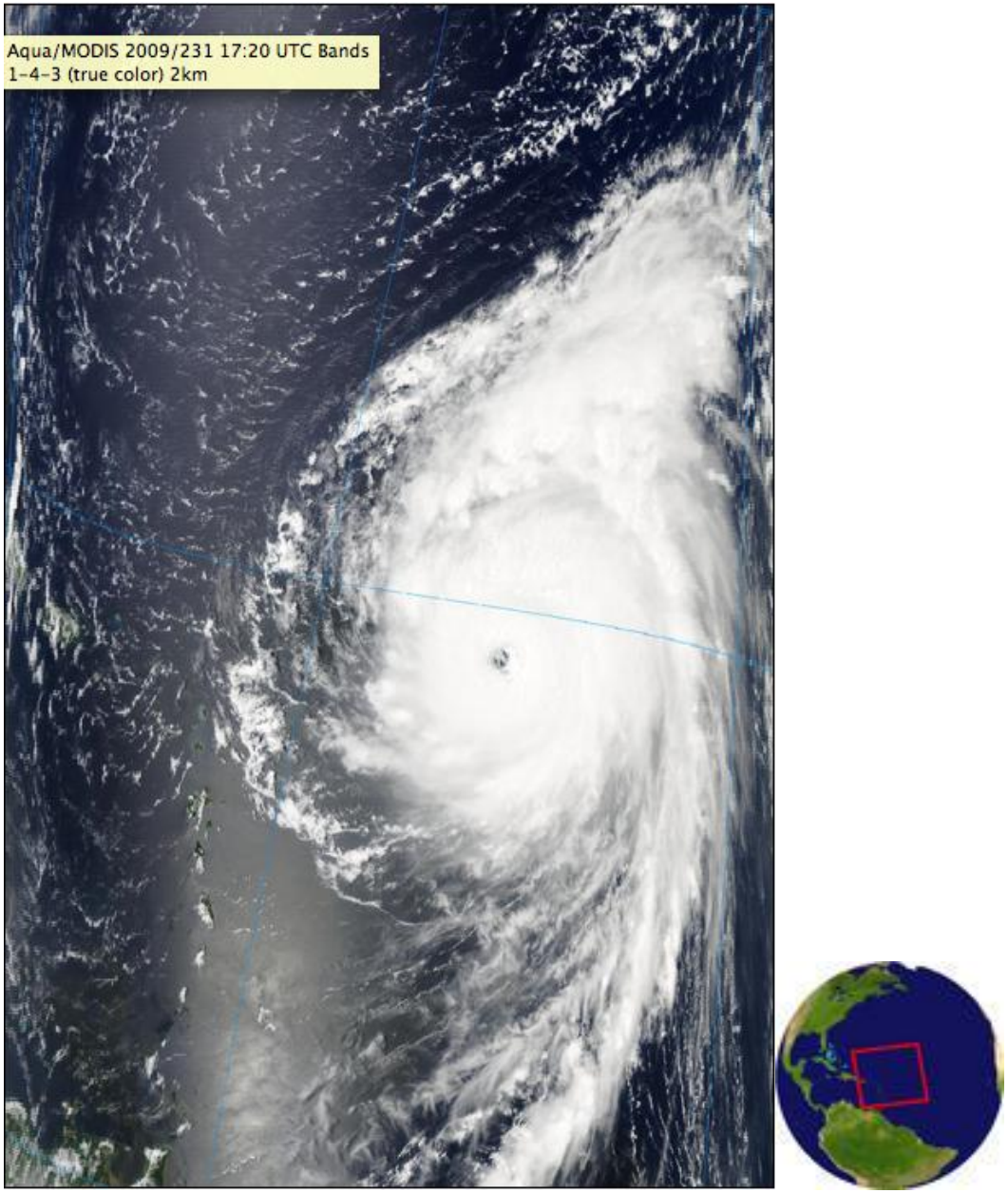
Background Summary:

The Earth's atmosphere extends above 700 kilometers (435 miles), yet almost all of the Earth's weather happens fairly close to the ground. Early attempts at studying the nature of the atmosphere used clues from the weather, the beautiful multi-colored sunsets and sunrises, and the twinkling of stars. With the use of sensitive instruments from space, we are able to get a better view of the functioning of our atmosphere. To do this, scientists use remote sensing instruments that are placed on satellites. These satellites are launched into space and orbit around the Earth. Remote sensing instruments are able to produce images of the physical properties and characteristics of objects without being in physical contact with them. This highly advanced technology forms images by gathering, focusing, and recording reflected light from the sun, energy emitted by the object itself, or reflected energy from the instrument itself. Using the information from the remote sensing instruments, the satellites help paint a picture of what is happening in Earth's atmosphere. People are familiar with some of the images generated, such as 'visible' images from space of cloud fields. These images are typically in black and white and are actually pictures of Earth from space. These images only show the topmost layer of clouds in the atmosphere. More advanced technology now allows us to see inside the atmosphere. Some satellites obtain images of the vertical profile of a spot in the atmosphere as opposed to looking down at the atmosphere. In this activity students will look at these types of images and make observations about the similarities and differences of these images.

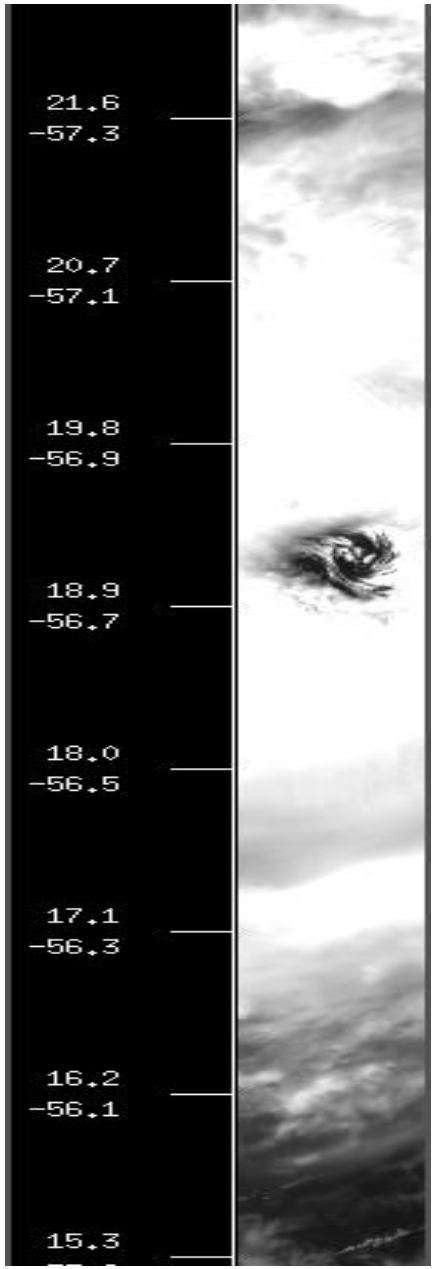
Steps:

1. Teachers may wish to begin this section of the activity with a discussion about "perspective". Sometimes perspective can also be used when we talk about the point of view from which we see something. Share with students an example of perspective. For example, if you have flown in a

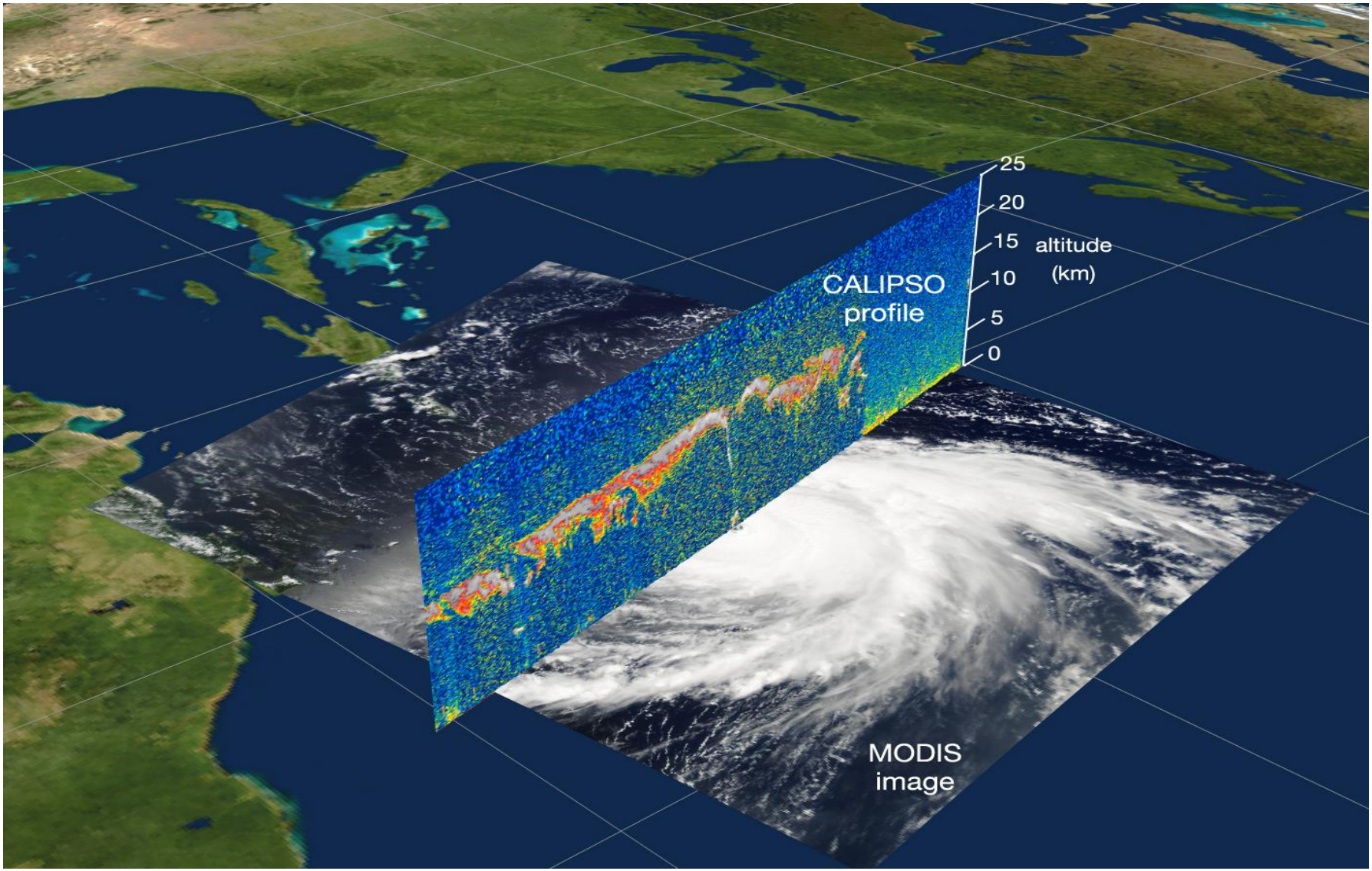
plane you may have thought how small buildings or cars look. Discuss how the cars are not really smaller than your thumb, but the cars appear this way because of how you are viewing them (in the air, on a plane).
2. Ask students to describe an apple. What are the responses? Some students described the color of an apple. Some students described the shape. Some students described the taste of an apple. Some students described how an apple grows. Discuss how each student had a different perspective on what describes an apple. Discuss how if we take everyone's description of the apple, we get a better and more complete, description about an apple.
3. Ask students if they have ever seen a picture (or image) of our atmosphere or of weather. Students may be familiar with images shown during the local weather segment of the news such as a weather map or satellite image showing clouds (using Visible or Infrared Satellites). Share some of these "common images" and ask students where they have seen an image like this before. Ask students to describe what the image shows. Discuss how these images are from the point of view of space. These images come from scientific instruments that are on satellites in space. The common images appear as though you are in space looking down at the Earth.
4. Discuss with students how there are other satellites that have the ability to "see" the atmosphere from a different perspective. These satellites show us what is inside the atmosphere- from the surface to the top of our atmosphere where it fades into space. Display in the front of the room the "overhead images" and "CALIPSO image" (or pass out handouts of the images to student groups).
5. In pairs, have students talk about what they see in the images. Have students discuss the similarities and differences between the two images.
6. Checking for Understanding: As a group, discuss the images of the same hurricane. Discuss the features that appear in one image but not the other. Discuss how they are similar.



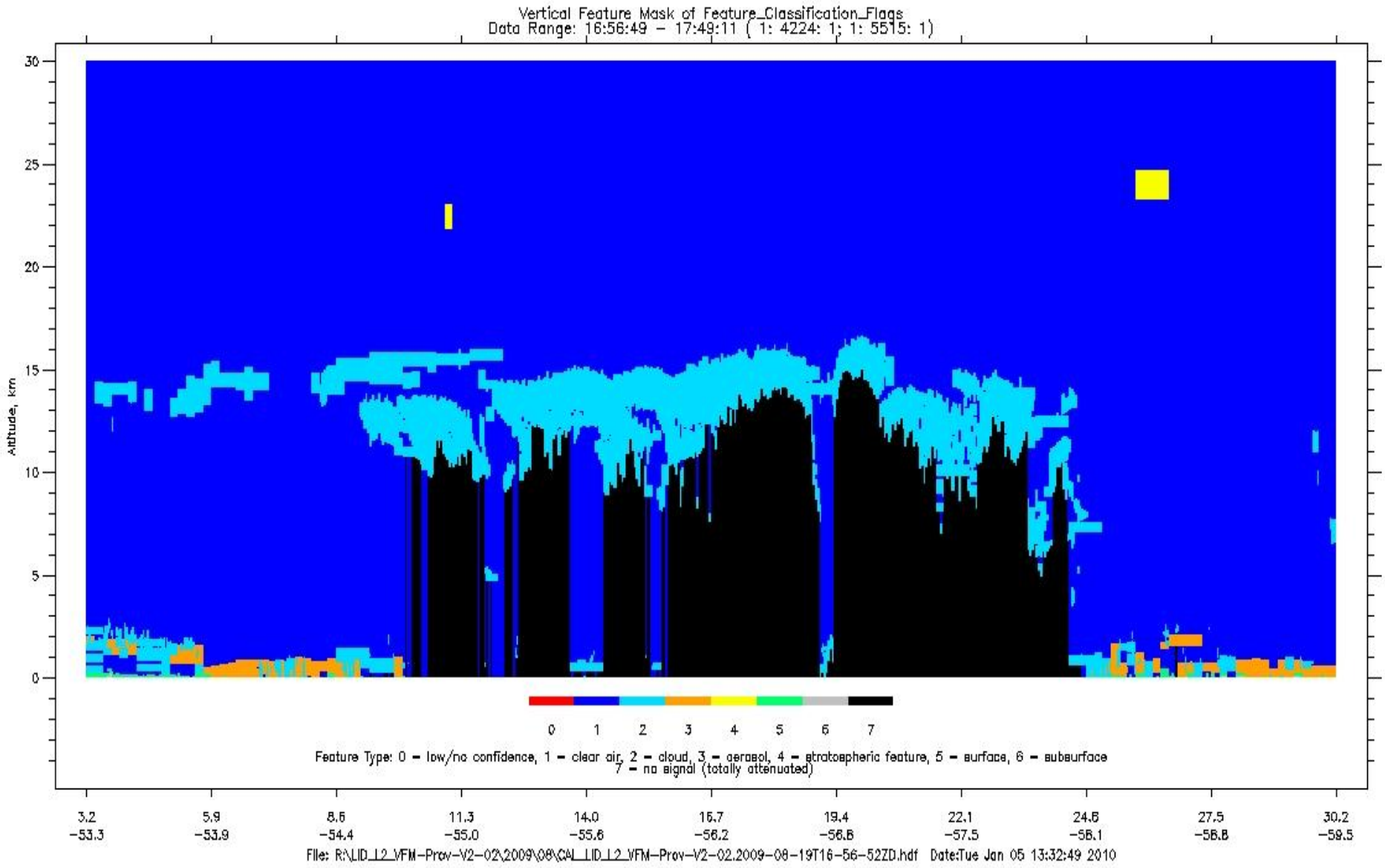
Overhead image 1: Image of Hurricane Bill in the Tropical Atlantic Ocean on August 19, 2009 taken by the MODIS instrument on the Aqua satellite. The inset shows the location of the image on the globe.



Overhead image 2: A narrow strip image of the eye of Hurricane Bill taken almost at the same time, from the Wide Field Camera on the CALIPSO satellite. This instrument looks at a narrow part of the Earth immediately beneath the satellite track.



Overhead image 3: Two perspectives on Hurricane Bill: A vertical profile from CALIPSO is overlaid on an image from MODIS as Bill moved northward on Aug. 19 at about 1:15 p.m. EST. MODIS captures the breadth of Bill and CALIPSO detected the upper portion of the hurricane's clouds structure. The eye of the storm can be seen as the break in the clouds just south of 19.70 N, about parallel with the southern coast of Cuba.



CALIPSO image: A vertical profile of the atmosphere obtained by the CALIOP Lidar instrument aboard the CALIPSO satellite. This laser instrument probes the atmosphere layers along the centerline of the strip image. Colors identify the feature that the satellite instrument detected. Clouds can be identified by the light blue color (color 2 on the color scale). The eye of Hurricane Bill can be seen at about 18.4 degrees latitude, above the grey segment of the color scale. Notice the thick 'wall' of clouds on either side of the eye.