## IV. CALIPSO Profile of the Atmosphere

**Learning Objectives**

Students will:

- Analyze features from a satellite image
- Plot distances (heights) on a graph

**Estimated Time:**

40 minutes

**Materials:**

- CALIPSO Profile Image
- U.S. Map
- Vertical Profile of the Atmosphere Graph

**Vocabulary:**

- **Latitude**- a measure that identifies the North - South location of a point on the Earth. It is the angle between the line connecting a point on the Earth and the Earth's center, and the equatorial plane of the Earth. There are three ways to express latitude. You may be most familiar with 0-90 North and 0-90 South. In the computer era this became -90 to +90, where -45 is equivalent to 45 South. The third method is less familiar and is called the colatitude. Colatitude is 0 at the North Pole, 90 at the equator, and 180 at the South Pole. So, 45 South is equivalent to a colatitude of 135. (http://mynasadata.larc.nasa.gov/glossary.php?&word=latitude)
- **Longitude**- a measure that identifies the east - west location of a point on the Earth. It is the angular distance along a line of latitude from the Greenwich Meridian - a reference longitude set to be zero degrees. There are three equivalent ways to express longitude, and scientists tend to use them interchangeably. You may be most familiar with longitude as 0-180 East, and 0-180 West. It can also be expressed as 0-360 East, or just 0-360. In that case, 270 East is equivalent to 90 West. The third system arose in the computer era, when carrying both a number (0-180) and a character (East or West) was inconvenient. The new convention of -180 to +180 was then developed. In this case, -90 is equivalent to 90 West. (http://mynasadata.larc.nasa.gov/glossary.php?&word=longitude)
- **Graph**- a visual representation of a particular data set.

**Background Summary:**

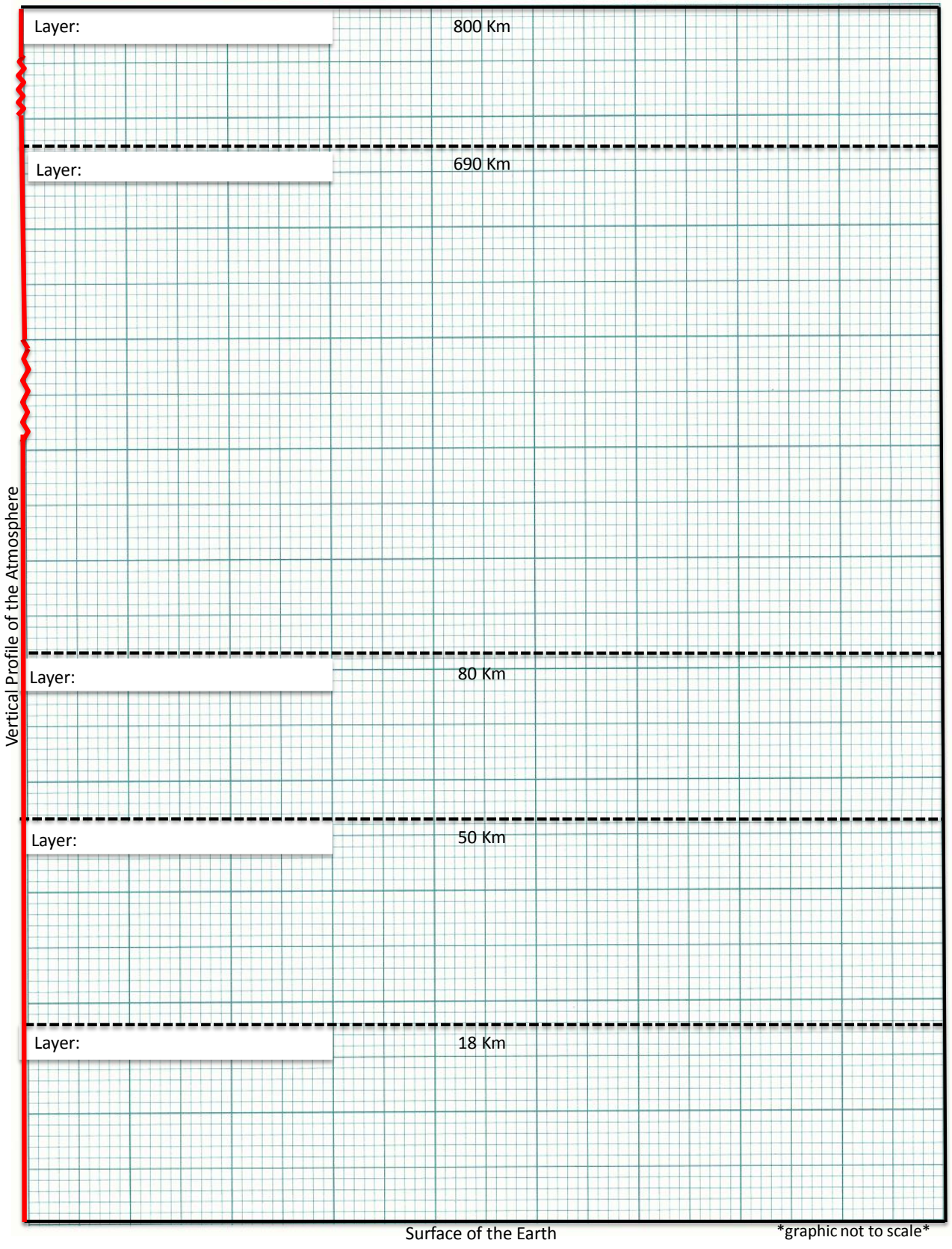
In the previous activity students learned about how some satellite images look down at the Earth's atmosphere and others have the ability to "see" inside the atmosphere. The satellite that shows us inside the atmosphere is called CALIPSO. Instead of looking at the clouds over a large geographic area, such as the entire United States, CALIPSO looks through the atmosphere at a particular point. Imagine a laser beam traveling from the satellite in space through all the layers of the atmosphere to Earth. This beam even travels through some clouds to "see" what is below the clouds. The images from CALIPSO allow us to see vertical features of our atmosphere such as clouds and aerosols (smoke, dust, etc) in the air. Since CALIPSO uses a laser beam that often reaches all the way down to the surface of the Earth, the images can also show land features, like mountains. In this activity students will take a CALIPSO image and identify the atmospheric features then analyze the image to identify the altitude of these features. Students will then put these features on their own graph of the atmosphere.

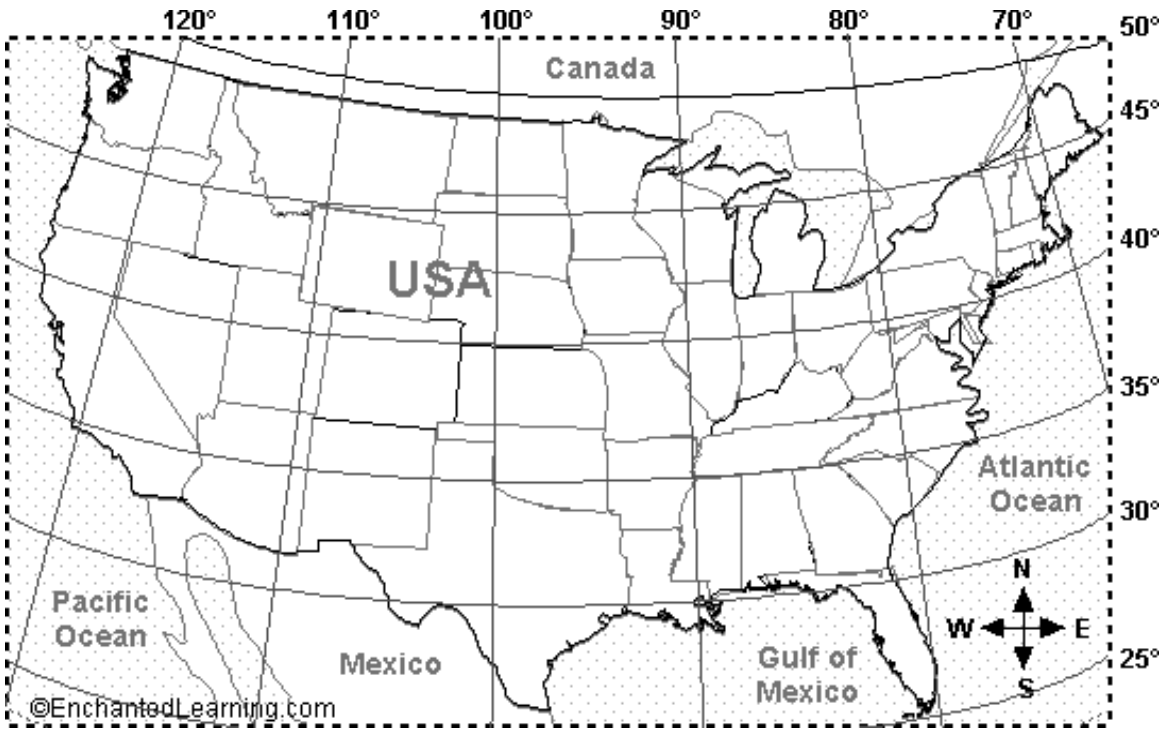
**Steps:**

1. Pass out or display the CALIPSO image. In the second activity students worked on creating their own graph that displayed the vertical profile of the atmosphere. Before students can take the CALIPSO image and transpose these features onto their own graph, they first need to be able to understand the image they are looking at.

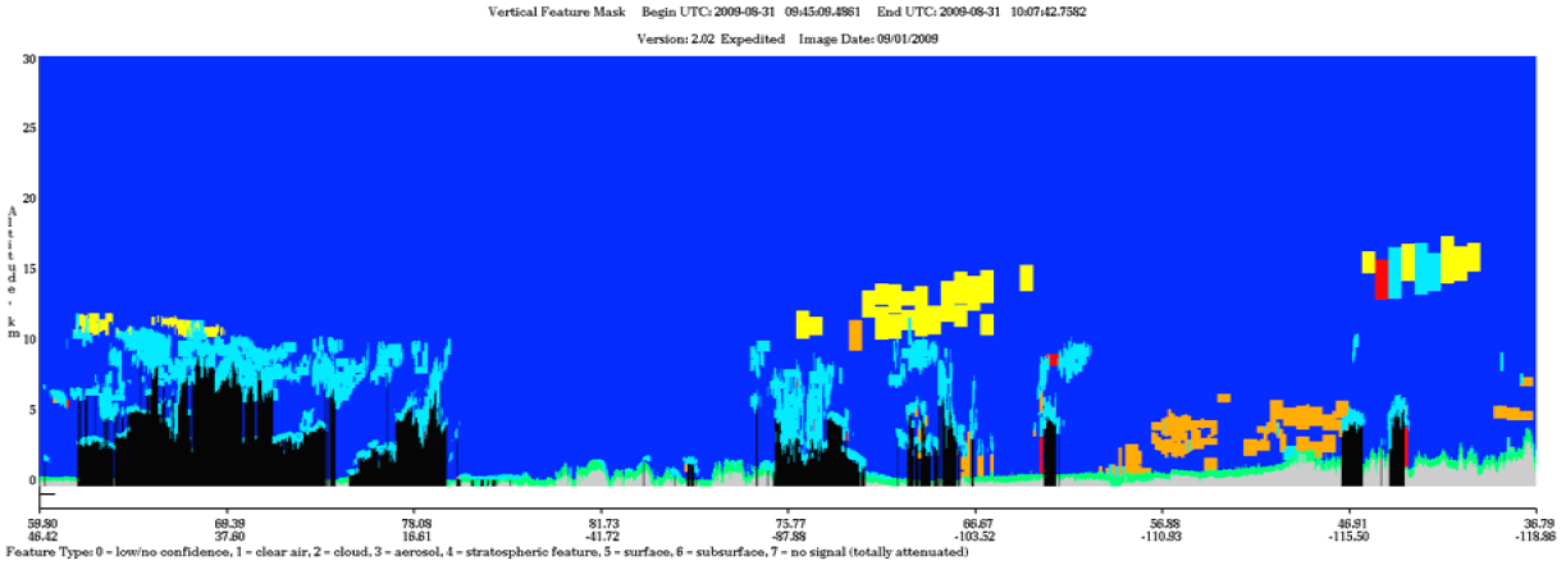
2. Show students the track of the satellite. This track shows you the path of the satellite. Pass out the ***U.S. Map*** to students. Have students point out where your current location is on this map. Using the CALIPSO image displayed in the front of the classroom, have students identify the latitude/longitude reference on the image (along the bottom of the image). Now, using the overall path as a guide and the CALIPSO image displayed, have students draw a line on their map showing the track of the satellite image.
3. Pass out the ***Vertical Profile of the Atmosphere Graph***. Discuss with students what the X-axis represents (horizontal distances) and the Y-axis represents (vertical distances). The Y-axis on their graph represents the same thing as the Y-axis on the CALIPSO image (altitude or height).
4. Have students draw the altitude of the CALIPSO satellite (about 700 km). Using this graph discuss with students how the satellite "sees" the atmosphere by shooting a laser beam straight down from space, through the layers of the atmosphere, to the ground. Students can take their finger and trace an imaginary line from the satellite to the ground.
5. Now that students have a general idea of how the image displays a vertical profile have the students look at the CALIPSO image. In pairs, have students talk with a partner about what they "see" from the CALIPSO image.
6. As a group discuss with students how they can determine what the feature is they are looking at (by checking the color bar) and how they determine the height of this feature in the atmosphere (by checking the Y-axis to determine altitude in km).
7. Using the CALIPSO image, have students draw on their graph the features displayed in the CALIPSO image (i.e., clouds, aerosols, surface features).
**8. Checking for Understanding:** Have students explain how they determined the height of the clouds on the CALIPSO image and how they used this information to draw clouds on their own graph. *At what height(s) are the clouds, aerosols, and top of the mountain? Ask students- In which layer of the atmosphere are these features? (Questions depend on image)*

Vertical Profile of the Atmosphere Graph






U.S. Map with latitude longitude to locate the CALIPSO image




CALIPSO image from August 31, 2009 during the Station Fire near NASA's Jet Propulsion Laboratory