Tools of the Atmospheric Scientist

Lesson #6
- Measuring Cloud Heights

Micropulse Lidar

Target Level - Middle School/Junior High

Clouds can be classified by both their appearance and by the altitudes at which they occur. When we group clouds by appearance, the three basic types are the familiar fluffy and rounded cumulus, the feathery cirrus, and the flat and layered stratus. Combinations of these three cloud types can also occur such as cirrocumulus and cirrostratus. When we group them by the height at which their base occurs, they are divided into low level, middle level, high level, and vertically developed clouds (Fig. 1).

Scientists seek to better understand how sunlight and clouds interact to affect the Earth's climate. In order to accomplish this goal, there exists the need for an accurate measurement of the height of an overhead cloud.

Fig. 1 - Clouds Over Nauru
(Credit - ARM)

Fig. 2 - Micropulse Lidar, MPL
(Credit - ARM)

One instrument which ARM scientists employ to measure cloud height is the Micropulse Lidar. Lidar is an acronym for light distance and ranging and operates much like conventional radar. A modified 8 inch telescope directs bursts from a laser into the sky directly above the instrument. When these pulses of laser light travel through the sky, they may encounter tiny water droplets which comprise a cloud or aerosol particles. The light is scattered as it "reflects" off the particles and some bounces directly back to the instrument below. Based on the time it takes the scattered and reflected pulse to return to the surface, the height of a cloud base can be accurately determined (Fig. 2).

Sample data from the Micropulse Lidar is shown in Fig. 3. The left vertical axis represents the range height in kilometers. The MPL instrument can be used to determine the altitude of the base of a cloud or aerosols up to nearly 20 kilometers. The lowest detected cloud base in the vertical column above the instrument is generally what is recorded on the data plot. The time scale at the bottom of the graph is shown in Universal Coordinated Time (UTC), which is six hours ahead of SGP local time during standard time and five hours ahead during daylight savings time.

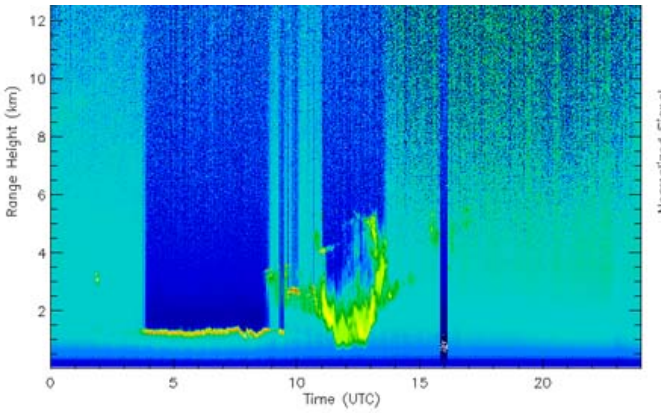

Fig. 3 - Sample MPL Data Plot - Click
(Credit - ARM)
Click on picture for larger view

Click on Fig. 3 to view the larger version of the image. Using the left vertical scale, what would be the height of the cloud base for each two clusters displayed on the image?

Activity - Measuring Cloud Heights

1. Go to the ARM SGP MPL site and select a date for the current or previous month which clearly shows clouds being detected by the instrument.

2. Use the left vertical scale to estimate the height of the lowest cloud base displayed in the image.

3. Go to the ARM SGP MMCR site and select the same date.

4. How does the lowest cloud base in the MPL image compare to that determined by the MMCR image?

5. Which instrument displays a more clearly defined cloud base?

6. Which instrument can be used to more accurately measure the cloud thickness from the base to the top?

Interpreting the Data

1. If the base of a low level cloud is generally found between 0-2 km, the base of a middle level cloud between 2-7 km, and the base of a high level cloud between 7-18 km, determine the type of clouds detected in the MPL image you selected.

2. The base of a vertically developed cloud usually occurs between 0-3 km. Could the clouds detected by the MPL data plot you selected be vertically developed?

3. Use the ARM SGP MPL site to find examples of the other varieties of clouds as classified by the height of their cloud base.

Congratulations! You have taken another step in understanding how meteorologists use atmospheric data to help monitor and forecast the weather.

National Science Education Standards

Annotated by MCREL (Standard - Level - Benchmark)

Standard 1. Understands atmospheric processes and the water cycle: 1-III-1, 1-III-2, 1-III-4, 1-III-6

Standard 9. Understands the sources and properties of energy: 9-III-8, 9-III-9

Standard 11. Understands the nature of scientific knowledge: 11-III-2

Standard 12. Understands the nature of scientific inquiry: 12-III-1, 12-III-5, 12-III-6, 12-III-7

Standard 13. Understands the scientific enterprise: 13-III-3