MY NASA DATA Lesson:

Using Radiosonde Data From a Weather Balloon Launch

Image courtesy MY NASA DATA Team

Purpose:

Students will use radiosonde data from a weather balloon launch to distinguish the characteristics of the lower atmosphere.

Grade Level: 7-12

Estimated Time for Completing Activity:

50 minutes

Learning Outcomes:

- Students will learn the layers of the atmosphere.
- Students will graph real atmospheric data.

Prerequisite

- Basic information about the layers of the atmosphere
- Understanding of the relationship of temperature and moisture to humidity
- Familiarity with using Excel

Tools

- Computer with Internet access
- Excel or other spreadsheet technology

Vocabulary:

- atmospheric pressure
- dew point
- longwave radiation
- radiosonde
- relative humidity
- shortwave radiation
- stratosphere
- temperature
- troposphere

Lesson Links:

- Radiation Budget Diagram
- Vertical Structure of the Atmosphere
- Altitude Temperature Pressure Figure
- Radiosonde data from July 26, 2005
- More radiosonde data from Univ. of Wyoming

Background:

Our atmosphere is warmed by shortwave radiation received from the Sun. Some of the energy is reflected back to space depending on cloud cover and the surface characteristics of Earth. Some of the energy is absorbed by the surface, then re-emitted back to space as longwave radiation. As this occurs, clouds and atmospheric gases can reflect, absorb and re-emit this energy — the so-called greenhouse effect. This naturally-occurring balance of energy makes Earth habitable.

Most human activity and weather occurs in the troposphere. The air temperature generally decreases with height away from the surface. In the stratosphere, the ozone layer absorbs the energy from the Sun, protecting us from harmful ultraviolet radiation. The temperature in the stratosphere actually increases with height because of this. Where this thermal reversal occurs is the boundary between the troposphere and stratosphere called the tropopause. The tropopause is not the same height everywhere. It is higher in the tropics than at the poles.

To form clouds, evaporated moisture needs to condense into droplets. Before that can occur, the air must become saturated (humidity must reach 100 percent). Usually, this

occurs when moist air rises and cools. The temperature when saturation occurs is called the dew point temperature. When air temperature equals dew point temperature, clouds will be found.

In this exercise, students will examine air temperature, dew point, and air pressure data collected by radiosonde. The data is from a weather balloon launch at NASA Langley Research Center in Hampton, Virginia, on July 26, 2005. Students will determine the location of the tropopause and decide if any clouds formed.

Procedure:

First, read and discuss the informative links above regarding the vertical structure of the atmosphere and the relationship between altitude, temperature and pressure.

1. Click the Lesson Link above to access the radiosonde data.
2. Save the data as a file on your computer in a location easily accessible (such as your Desktop).
3. Open Excel and select Import or Get External Data under the Data menu. Click on Import Text File.
4. Use the Browse window to select the radiosonde file on your Desktop or other file location.
5. A Text Import Wizard window should appear. On Step 1, Select Delimited. Be sure to Start Import at row 106 where the profile data begins. Click Next. On Step 2, Select Space Delimited and Finish. Delimiters are what separate columns of data. The data should now be neatly organized in the spreadsheet.

Note: If you use other radiosonde data, scan the data and, if necessary, remove missing values of dew point and corresponding temperature data. Column A may need to be deleted if empty. Make sure column labels align properly with their units.

6. Highlight the three columns labeled Pressure (hPa), Temp (degC) and Dewp (degC) which should be columns E,F,and H for this data.
7. Click the Insert on the Menu bar, and Select Chart.
8. With Chart Wizard open, choose the XY scatter plot with connecting line (no markers). Click Next.
9. Excel may default to use Pressure as the X-axis. You must tell Excel to switch Pressure to be the Y-axis. To accomplish this, Select the Series tab on Step 2, and Select Series, Temp degC. In the text box, substitute Column E values as your Y-axis, Column F values as your X-axis. Next, Select Series, Dewp degC. Likewise, substitute Column E values as your Y-axis, Column H values as your X-axis.
10. Click Next. You may type a Chart Title such as Radiosonde data. Label x axis as Temperature (C). Label y axis as Pressure (hPa).
11. Generate the graph by selecting Finish. Place in worksheet by clicking OK.
12. We need to reverse the Y-axis because pressure decreases with height in the

atmosphere. Double click on the Y-axis to get a pop-up window. Under Scale, set the minimum value to 0, set the maximum value to 1020. Click Values in reverse order. You may also move the X axis to cross at 1020 (at the bottom).

13. The graph should show two lines that slant backward because temperature generally decreases with height in the atmosphere. Where the lines meet, cloud layers form because temperature and dew point temperature are close in value (saturation and condensation occurs).

Questions:

1. Mathematically, how do pressure and temperature decrease with altitude (linear, logarithmic)?

2. Do the temperature and dew point temperature ever meet on this day? Do you think any clouds were visible?

3. Can you find the tropopause in the data? At what altitude or pressure does it occur?

Extensions:

1. After analyzing the data with a graph, students can make a pictorial scale wall chart. Ask students to label altitudes and atmospheric layers. Ask students to find graphic representations of what they would find in each layer such as animals on the ground, jet planes at their altitude, balloons, satellites and the International Space Station in their proper distance.

2. To give students a better perspective on the thinness of our atmosphere, ask students to find a local city or town near their location that is the same distance away as the distance from the surface to the top of the atmosphere.

3. Find other radiosonde data on the Internet (see Lesson Link) for other locations and dates. Make Excel graphs using similar procedure, and determine cloud layers and other features.

4. Hypothesize the patterns you would expect to see regarding the relationship between land and ocean temperatures. Compare radiosonde graphs of a location inland and a location near the coast or on an island. Discuss your findings.

Lesson plan contributed by Carl Hendricksen, Dunlap, Illinois

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