MY NASA DATA Lesson:

Cold, Clouds, and Snowflakes

Image courtesy USDA

Purpose:
To use satellite data to explore the relationship between the amount of water vapor and the temperature of clouds, as well as snowflake shapes and cloud temperature

Grade Level: 4 – 7

Estimated Time for Completing Activity:
90 minutes

Learning Outcomes:

- Students will locate and use NASA satellite data to create graphs.
- Students will draw conclusions from maps and graphs.
- Students will use formulas to convert measurements.
- Students will determine the latitude and longitude from a map location.

Prerequisite

- Familiarity with the use of latitude and longitude
- Previous practice with evaluating mathematical expressions
- Previous knowledge in states of matter (solid, liquid, gas)
- Overview of Winter Precipitation Types

Tools

- Computer with Internet access
- Map or Altas
- Microsoft Word or other word processing software

Vocabulary:

- accretion
- aggregation
- latitude
- longitude
- precipitation
- snow and ice
- sublimation
- temperature
- water vapor

Lesson Links:

- Overview of Winter Precipitation Types
- Applet to Grow Snowflakes
- Live Access Server

Background:

Snow and ice are both precipitation, that is, the processes that remove water from clouds. Clouds, regions of the atmosphere with high relative humidity, are made of droplets of water and perhaps bits of ice. Even though water is much denser than air, these droplets and ice crystals are small enough to be suspended by random upward air motion. When these droplets or crystals join together, gravity overcomes the suspending force and we have precipitation.

Cloud temperature, which varies within a cloud, affects the crystal shape of snowflakes. For instance, large, dendritic flakes grow best at temperatures of -10 to -12 degrees Celsius, while plates grow at warmer and colder conditions. If the flake passes through dry air, it may sublimate. If other ice crystals are present, they may aggregate onto the crystal. If liquid water is present, it may accrete. All these processes can alter snowflakes shapes.

In this lesson, you will investigate NASA satellite data to determine geographical areas where wintry precipitation may have occurred based on cloud top temperature. You will use tables of snowflake formation versus temperature to determine what shapes of crystals likely occurred.

Procedure:

1.Use the Live Access Server to prepare two color plot maps which display the average cloud top temperature and the annual precipitation for January of 2004. To do this
a. Click on the Lesson Link for the Live Access Server
b. Select Atmosphere, Clouds, Cloud Temperature, Monthly Cloud To Temperature for Low Clouds (ISCCP)
c. Change the time to January 2004. Be sure to check the 'Update Plot' radio button to see your data changes.
d. The default temperature is Kelvin. It can be converted into Celsius in LAS using Evaluate Expression (this can be found under Plot Options in the upper menu).
e. Be sure to save or print the plot for later analysis.
f. Repeat step 1 to generate a second map. This time choose parameters Atmosphere, Precipitation, Monthly Precipitation (GPCP)
2. Discuss with your class what areas you think would have had snow in January.
3. Using a world map or atlas, pick a location that you think will have had snow, and locate a city near that area.
4. Open a Word document and record the name of the city, country, latitude, and longitude. From your LAS map, record the cloud top temperature.
5. Use the formula (mm per day X 14.4 = inches per year) to find the annual precipitation for your city.
6. Do a search on the Internet to find a picture of the city as well as the following information: language spoken, population, and elevation.
7. Using LAS, create time series graphs that when compared side by side compare the Monthly Cloud top temperature to the monthly lower troposphere precipitable water. Do this by
a. Click on the Lesson Link for the Live Access Server
b. Select Atmosphere, Clouds, Cloud Temperature, Monthly Cloud Top Temperature for Low Clouds (ISCCP)
c. Under 'Line Plots' Select 'Time Series' and in the compass rose box input your chosen location, and then change your time range to a 3-year span before January 2005. Save this graph file, then insert it into your Word report on a new page.
d. Be sure to click on the 'Update Plot' radio button to see your data plot changes.
e. For the second plot repeat steps a through e with the following data set options Click on Atmosphere, Atmospheric Water Vapor, and then Monthly Lower Troposphere Precipitable Water (1000-680 mb) (ISCCP)

8. Determine the Celsius temperature of your city from the LAS map and use the Applet to Grow Snowflakes (Lesson Link) to create an image of what the snowflake would look like in that area of the world with that cloud top temperature. Next, use the print screen, copy, paste, crop, and wrap functions of the computer to paste the image into your Word document.
9. Print the reports and chart.
10. Tape all of your charts on a world map near the location of the city.

Questions:

1. How are the graphs of all of the cities the same? How are they different?

2. During what months are the temperatures of the cloud tops the warmest? During what months are they coldest?

3. During what months does the lower atmosphere have the highest amount of moisture? During what months does it have the lowest amount of moisture?

4. When the atmosphere has low moisture, what seems to be true of the temperatures of the cloud tops? When the atmosphere has high moisture, what seems to be true of the temperatures of the cloud tops?

5. How does the temperature of the tops of the clouds relate to the amount of moisture in the atmosphere?

6. Are the shapes of the snowflakes all the same? What makes the shapes different?

7. What types of symmetry do the snowflakes with dendrites and plates have?

8. How many lines of symmetry are there?

9. What is the angle of rotational symmetry?

10. Determine the number of faces, edges, and vertices of the prisms and columns.

Extensions:

1. Collect the elevation and annual precipitation from all of the cities and chart them on a scatter plot in Excel to see if there is a relationship.

2. Collect annual precipitation and north latitude from all of the cities and chart them on a scatter plot in Excel to see if there is a relationship.

3. On snowy days, collect snowflakes on cold, black paper. Examine them with hand lenses to determine what their structure is. Use NOAA or National Weather Service sites to find out what the cloud temperature was as well as the amount of water vapor.

4. Generate a 3rd map of near surface temperature and see how well it matches with the map of low cloud top temperature

Lesson plan contributed by Mary Stander, Princeton, Illinois

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