Comparing Temperature, Pressure, and Humidity

Between the Tropics, Arctic, and Southern Great Plains
Using ARM Program Data

Grade:
6th – 9th

Duration:
1 or 2 weeks total, 30 minutes to 1-hour class time a day.

Goals:
Students will be able to download atmospheric data from the ARM website. They will compare the data from three different locations in the world, discuss why it is different at each location, and be able to answer questions about the data.

Objectives:
Students will be able to:

- Learn how to compare data on temperature, pressure, and humidity.
- Learn how to do unit conversions.
- Make graphs of the data.
- Understand how to interpret a graph.

Materials:
Daily use of a computer with Internet access.
Record sheet (see below).
Software such as Excel for making graphs OR graph paper and colored pencils.
World map

Introduction:
The ARM Program has high-resolution data collecting instruments at each of the three sites, the North Slope of Alaska (NSA), the Southern Great Plains of the US (SGP), and the Tropical Western Pacific (TWP). These instruments make up the largest remote sensing array of equipment in the world and collect data that is of the highest resolution for a ground based weather station. This activity is for classes to compare data from three very different places in the world, and may be used in conjunction with a classroom unit on weather and climate.

Why does the ARM Program take all this data? The ARM project's goal is to study certain aspects of how the atmosphere works to help make global and regional climate predictions more accurate and therefore more useful. At each ARM site, data is collected, and this data is then used to evaluate and improve the elements of Global Climate Models – large computer programs that simulate how the entire earth's atmosphere and oceans behave. By using data from the ARM sites, we learn how we can more accurately represent what is really happening in the world's climate with Global Climate Models.

Why does ARM take data in these three different places? Scientists gather and use the data from these sites to study the effects of sunlight, radiant heat, and clouds on temperature, weather, and climate. By having ARM sites in very different locations from the Tropics to the Arctic, we can learn how to improve the accuracy of the models over the whole surface of the earth. To understand the difference between weather/climate and changes that take place in a given environment, check out the ARM Program lessons on Current Weather and Weather and Climate/Climate Statistics.

In this activity, the students will be comparing **temperature**, **pressure**, and **humidity** for the three different sites, the Arctic, the Great Plains of the US, and the Tropics.

Temperature: Temperature is one of the most frequently measured quantities in science. The temperature of the air is directly related to the amount of energy that is derived from the sun's solar radiation. The higher the temperature, the higher the amount of energy in the air. Temperature is measured using a thermometer with units in degrees Celsius or Fahrenheit. See http://www.teachervision.com/lesson-plans/lesson-343.html for a lesson on how to make temperature conversions between Celsius and Fahrenheit.

Pressure: Though you may not realize it, the air has weight. All the air molecules in the atmosphere exert a force, or pressure, on our bodies. Atmospheric pressure is the force exerted by the weight of the air above an object or surface. Variations in pressure generate winds, which play a significant role in day-to-day weather conditions.

An instrument used to measure the atmospheric pressure is known as a barometer. Pressure can be measured in different units. In aviation and television weather reports, pressure is given in inches of mercury ("Hg), while meteorologists use millibars (mb), the unit of pressure found on weather maps. Some scientists measure pressure in Pascals (Pa) as well. Check out our lesson on Air Pressure as well.

Humidity: Humidity is a measure of amount of water vapor or moisture in actually in the air at a certain temperature. At higher temperatures air can hold more humidity. The amount of water vapor in the air varies. The percentage of water vapor in the air compared to what the air can hold at that certain temperature is called the relative humidity.

Humidity is measured using an instrument called a hygrometer. The standard hygrometer measures the difference in temperature of the air and that of a thermometer attached to a wet wick known as a wet and dry bulb thermometer. If the relative humidity of the air is low there is a lot of evaporation from the wet bulb. The resulting cooling causes the wet-bulb temperature to be much lower than that of the dry-bulb temperature. However, if the air is very moist there will be little difference between the wet- and dry-bulb temperatures. The larger the difference between the wet- and dry-bulb temperatures, the lower the relative humidity.

For clouds to for, and rain to start, the air has to reach 100% relative humidity, but only where the clouds are forming. This normally happens when the air rises and cools. Often, rain will fall from clouds where the humidity is 100% into air with a lower humidity. Some water from the rain evaporates into the air it's falling through, increasing the humidity, but usually not enough to bring the humidity up to 100%. To learn about the conditions that must be present for clouds to form, try our lesson on Making Clouds.

Activity 1:

Get out a map of the world. Find each of the three areas the ARM Sites are located, and mark them on the map. Use the Internet to find out a little about each of these areas.

1. Teachers: break the class into groups and have them research something about one of the 3 areas and report back to the class. What kind of food to people eat, what do people do for fun, what do people do for work. Learn as much as you can about each place.

2. After completing Activities 2 and 3, discuss:
    a. How the climate impacts how people live in each of the ARM Site areas.
    b. Why local knowledge on weather and climate is so important to people on a day-to-day basis. Examples: If you live on an island in the tropics and you need to get to the other side of the island in your boat, how important is it that you understand your local weather patterns? What about the Inupiat eskimo hunter on the North Slope of Alaska?

Activity 2:
Measure and record your own temperature data. Compare your data to the ARM data from the 3 sites (See Activity 3).

Teachers: If possible, Activity 2 and Activity 3 should be done during the same week.

1. Every day, go outside into the schoolyard and measure the temperature. Try to take the measurements at about the same time each day that you record the ARM data (See Activity 3). Record the readings on the Data Recording Sheet.

   Note: place an outdoor thermometer in an outdoor location where it will not receive direct sunlight. This location should not be in an area where it will be disturbed. At a given time each day, the teacher will allow student researchers to check the temperature and report it to the class.

2. Analyze the data by finding the average temperature at the end of the week.
3. Create a graph that plots out temperature. Discuss any temperature changes you saw during the week.
4. Compare this graph with the graphs made in Activity 3. Discuss the differences you see in the temperatures you recorded with the temperatures at the ARM Sites.

Activity 3:
Compare data from the three ARM Sites, the North Slope of Alaska, the Southern Great Plains of the US, and the Tropical Western Pacific. You can use the Data Recording Sheet provided.

1. Select the type(s) of data you want to compare (temperature, humidity, and/or pressure).
2. Go to the ARM websites daily to download the data for each of the variables you are comparing for each of the sites. See below for the instructions on how to download data from the ARM websites.
3. Write the data for each day in the corresponding space in the chart. *Try to record the measurements about the same time each day*.
4. Analyze the data. At the end of the week, find the average of each of your data (For example, the average temperature). Make conversions to the correct units if necessary.
5. Create a graph for each variable to demonstrate and compare the data. This can be done by using graphing software such as Excel, or by hand using graph paper and colored pencils.
6. Compare the data from the three different places and discuss why the results differ (season differences, climate difference etc.)

Instructions on how to download ARM data:
Getting the data for each location may seem complicated at first, but don't despair! After going through it once, you will be a pro.

Southern Great Plains:
Real time hourly data can be found at http://nsdl.arm.gov/~cmnsdl/quicklook/smos/site_wide.html.

- Temperature: Scroll down to the plot that is labeled "Temperature Contours". Pick a site location that you will use the entire week (such as the dot labeled E3 in the upper right hand corner of the plot).

  Record the temperature at this site by finding the temperature contour closest to this site and recording that temperature on your Data Recording Sheet.

Note that the temperatures are recorded in degrees Fahrenheit. Make a conversion to degrees Celsius if needed (Teachers: you will have to decide if you want your students to record their data in degrees Celsius or degrees Fahrenheit.).

- Humidity: Scroll down to the "Relative Humidity Contours" plot. At the same site location, record the humidity at this site. Humidity is given in a percentage, such as 70%.

- Pressure: Scroll down to the "Sea Level Pressure Contours" plot. At the same site location, record the pressure closest to this site. Pressure is given in millibars (mb). See http://asd-www.larc.nasa.gov/SCOOL/pressunit.html to read about pressure units.

Tropical Western Pacific:
Plots of each variable can be found for the TWP islands of
Manus: http://www.dmf.arm.gov/goes_summary.html
and Nauru: http://www.dmf.arm.gov/goes_summary2.html
Pick one of these locations for your data recording for the week.

Remember: When taking your data remember to use the same time of day each day for all of your data. So, if you are looking at a plot showing data for each hour of the day, be sure to pick a specific time, such as 11:00am and stick with this time for the entire week.

- Temperature: Scroll down the chart until you see "Air Temp". Click on "view plot" to see the plot of temperature for the day. Remember to record the temperature found at the time of day you are using for all your data. Note that temperature is plotted with triangles and the temperatures are shown on the left side of the plot.

  On this plot, temperatures are recorded in degrees Celsius. Make a conversion to degrees Fahrenheit if needed.

- Humidity: Scroll down the chart until you see "RH" which stands for Relative Humidity. Click on "view plot" to see the plot of relative humidity for the day. Remember to record the humidity found at the time of day you are using for all your data. Note that humidity is plotted with squares and the percent humidity is shown on the right side of the plot.

- Pressure: Scroll down the chart until you see "Atm pressure". Record the maximum atmospheric pressure as your pressure. Note that pressure here is recorded in hPa, which is the same as millibars. Thus, you do not need to make any conversions. Again, see http://asd-www.larc.nasa.gov/SCOOL/pressunit.html to read about pressure units.

North Slope of Alaska:
Plots of each variable can be found for the North Slope of Alaska at http://nanuna.gi.alaska.edu/nsadocs/nsaql.html. You cannot download NSA data for the same day. However, you can get the data for the previous day.

Important: On these NSA plots you will see data lines for different altitudes. Pick the line labeled "2 meters" and stick with it for getting all your data.

Remember: When taking your data remember to use the same time of day each day for all of your data. So, if you are looking at a plot showing data for each hour of the day, be sure to pick a specific time, such as 11:00am and stick with this time for the entire week.

- Temperature: At the left hand side of the screen, choose "twr", and then the appropriate start and end dates. For example, if you want data for August 2, 2002, you choose 08/02/02 as the start date and 08/03/02 as the end date. Next, click on "Search the DB".

Click on the GIF image for "temp" (Try clicking on this several times if it does not show the data the first time.). The first plot shows temperature in degrees Celsius. Record the temperature shown for the time of day you are using. Make the conversion to degrees Fahrenheit if needed.

- Humidity: After choosing "twr" and the appropriate start and end dates, choose the GIF image for "waterhum". Record the percent humidity for the time of day you are using.

- Pressure: After choosing "twr" and the appropriate start and end dates, choose the GIF image for "ptborg" to get a plot of atmospheric pressure. Record the pressure for the time of day you are using. Note that pressure is given in both hPa and millibars, which are the same thing. You can read about pressure units at http://asd-www.larc.nasa.gov/SCOOL/pressunit.html.

Questions:

1. Which location had the lowest/highest temperature? Humidity? Pressure? Discuss the climate at each of the locations.

2. What is the relationship between temperature and humidity? Did the class notice when temperature went up or down that humidity followed a particular pattern?

3. Is the area that is the warmest or coldest the most humid? Why?

4. Which of the three areas would you want to live in based on the weather you see? Why?

5. Which of these areas are by a large body of water? Do you think large bodies of water affect temperature? If so, how?

Other Related Classroom Activities:

1. Develop a list of questions you could send to a group of students in one of the other ARM locations. Start a "pen pal" project between your classroom and a class in one of the ARM Sites.
2. Invite a meteorologist to speak with your class about weather and climate.
3. Continue Activities 2 and 3 for much longer than a week…a month, a semester, or even the whole school year! This will give the class a chance to really compare the long-term changes, the climate, for each of the three areas.

Teachers:

We at the ARM Education Program would love it if you could send us input on how your class liked this project using real ARM data. Please send us a photo of your students working on this project and/or a student-made graph. We would love to display these on our webpage!

Thanks, Carrie Talus

talus@lanl.gov
ARM Educational Outreach Program
Los Alamos National Laboratory
EES - 10, MS J495
Los Alamos, NM 87545
Phone: (505) 667-6782

Standards:

National Education Standards:

Science:

Nature of Science:

- Standard 12: Understands the nature of scientific inquiry

Mathematics:

- Standard 1: Uses a variety of strategies in the problem-solving process
- Standard 4: Understands and applies basic and advanced properties of the concepts of measurement.
- Standard 6: Understands and applies basic and advanced concepts of statistics and data analysis

Technology:

- Standard 1: Knows the characteristics and uses of computer hardware and operating systems

Geography:

Places and Regions:

- Standard 5: Understands the concept of regions

World in Spatial Terms:

- Standard 2: Knows the location of places, geographic features, and patterns of the environment

Alaska State Content Standards:
Science: A-15, B-1, D-1
Mathematics: A-4, A-6, C-1, C-2, D-1, D-2, E-1
Geography: A-1, F-6
Technology: A-1, A-2, A-3, B-1, C-1
World Languages: B-2