AE447

4-H Weather and Climate Workshop[1]

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4-H Weather and Climate Workshop Whether you like it or not, Weather….it's cold, warm, or hot! Clyde W. Fraisse William R. Lusher Melissa Griffin Arthur A. Teixeira	SSS: I. Science: SC.A.1.3.3, SC.B.1.3.5, SC.H.3.3.7 II. Mathematics: MA.A.3.3.2, MA.A.3.3.3, MA.A.4.3.1, MA.B.2.3.1, MA.B.4.3.2 III. Visual Arts: VA.A.1.2.2, VA.A.1.2.4 SPS:

Instructor's Directions

This workshop is designed so any instructor can facilitate the information provided. It consists of introductory literature, a power point with a script, activities and worksheets. The suggested process for leading this workshop is for the instructor to read all introductory material, present the power point, and to facilitate the activities while using the provided worksheets. The power point includes a script, within the text there are numbers indicating the coordinating slide.

Pre and post-workshop questions can demonstrate the improvement in learning. The following are suggested as pre-workshop questions (discussion questions listed at the end of this document can be used as post-workshop questions):

- What is the climate of Florida? Tropical, sub-tropical, or temperate?
- What is the difference between climate and weather?
- Why are weather observations important?
- Can you think of places where you should not place a thermometer or rain gauge?

Objectives: *(What do students need to know to accomplish the purpose?)*

- Students will be able to conduct real scientific observations of the atmosphere.
- Students will be able to define relevant weather terms.
- Students will understand the importance of weather and climate.
- Students will know how to use a weather station, thermometer, rain gauge and cloud chart.

Equipment and/or supplies needed:

Data Entry sheet
Journal
National Weather Service cloud chart
Pencil or pen and most importantly, your eyes!
Nails (20)
Rain gauge
Water balloons (enough so each student can throw at least 5)
Plywood (4X4 ft)
Stand for plywood

Background/Resources (please explore the following websites before presenting the material)

Resources:

GLOBE Program: A NASA-funded science education program that trains teachers and students to conduct scientifically valid environmental observations. Some of the procedures used in this unit are based on GLOBE scientist-developed "protocols". They can be found at:
http://www.globe.gov/

CoCoRaHS Program: A NOAA-funded program that trains people to conduct precipitation measurements in their backyards. You can become a CoCoRaHS observer and submit your measurements to their online database to be used by a host of weather professionals - www.cocorahs.org.

Weather World 2010: A University of Illinois online meteorology classroom - http://ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/home.rxml.

National Weather Service Jetstream Online School for Weather: http://www.srh.noaa.gov/srh/jetstream/

INSTRUMENT SPECIFICATIONS/SUPPLIERS

All the instruments recommended in this unit have similar specifications to those recommended by the GLOBE program. However, since this is an educational unit and presumably none of the measurements taken will be used as scientific data, it is not imperative that instruments used for this unit conform to these standards. Below is a web link to a list of suppliers that carry instruments suitable for this unit:
http://www.globe.gov/fsl/html/templ.cgi?inst_suppliers&lang=en&nav=1

Below are recommended specifications as outlined by the GLOBE program:
Thermometer: U-tube type maximum/minimum; factory-calibrated to an accuracy of +/-1°; readable in degrees Celsius or Fahrenheit; scale marked in 1.0° increments; and readable to the nearest 0.5°.

Rain Gauge: Clear, at least 280 mm in height, with a collector at least 102 mm in diameter, and a scale readable to the nearest 0.2 mm.

Weather Shelter. The following two pages contain detailed plans for the weather shelter presented in the unit as outlined by the GLOBE program. This type of shelter can also be purchased from a number of science education instrument suppliers. The plans are also available for download at:
http://www.globe.gov/tctg/atinst.pdf?sectionId=7

BACKGROUND

The word meteorology is taken from the Greek word *meteoron*, meaning something that happens in the sky. A **meteorologist** is a person with a specialized education who uses scientific principles to study, explain, understand, observe, and forecast Earth's atmospheric conditions. Basically, a meteorologist uses science to study and predict the weather.

So what does it take to do the job of a meteorologist? Meteorologists use computers, RADARs, satellites, and weather **observations** to discover how natural processes and human activities affect our atmosphere. In this lesson students will get the chance to learn what it takes to do the job of a meteorologist. The most important job will be to observe what is happening with the weather every day and keep records, or write down what you see, in a **journal**, a book that contains data, observations and comments. So let's get started!

Setup:

SETUP

Before students go outside to take their observations, several items need to be set up outside. Ideally, they should be set up 24 hours before the workshop and the maximum/minimum indicators on the thermometer(s) should be reset so that, at the start of the workshop, the maximum/minimum temperatures recorded will represent the previous 24-hour period. If this is not possible, point out to the participants that normally the maximum/minimum temperatures represent the previous 24 hours.

I. **Weather Shelter**. This particular unit uses 2 weather shelters to demonstrate proper citing of weather instruments. If resources do not permit, one shelter can be used, with a simple discussion about proper citing. A weather shelter can be purchased as a pre-constructed unit or built using a set of plans.

The weather shelter should be mounted on either a post or tripod, and ideally placed on a natural surface in an open area away from trees and buildings. This minimizes the influence of man-made objects on the temperature and rainfall. The opening of the shelter should also face away from the equator, or toward the north to minimize the effects of direct sunlight on the thermometer.

II. **Shelter Setup.**

a) Place one shelter in as ideal a location as possible: on a natural surface, away from buildings and trees, facing north.

b) Place the other shelter in a less-than-ideal location: such as close to a building or under a tree, on a paved or concrete surface, facing south.

III. **Thermometer**. The thermometer should be located inside the shelter and attached to the back “wall” (as in the picture, or according to the plans). Ideally, place a 2-liter soda bottle cap between the thermometer and the wall of the shelter (1 near the top and 1 near the bottom) so the heating and cooling of the shelter surface do not influence the thermometer.

IV. **Rain Gauge.** The rain gauge should be mounted to the back of the shelter with the top of the gauge extending above the top of the shelter (as in the photo below) in order to minimize the possibility of rain splashing from the shelter into the gauge.

V. *Balloon Toss*. The Balloon Toss is a fun activity that demonstrates the variability of rainfall, and allows participants to practice reading the rain gauge. The apparatus for this activity needs to be constructed, and can be built fairly easily using 2x4 sections of wood and plywood (see photo below). Basically, the apparatus consists of a piece of plywood attached to a stand. The plywood should contain a grid of equally spaced nails throughout the top half, and a rain gauge mounted in the center of the bottom half. Participants "toss" water balloons at the grid of nails attempting to break them. When the balloons break, some of the water falls into the rain gauge. After a number of balloons break, participants can read the "rain" that has collected in the gauge. This activity can be set up in any open space that will allow participants to stand approximately 10-20 feet away from the apparatus.

Now, everything should be set up for the workshop, and you can proceed to presenting the content.

Workshop: (Power Point Script)

SLIDE PRESENTATION

(3) Weather is everywhere. It affects almost everyone, whether you're a kid or an adult, or even an animal. Weather even affects plants. Weather can affect us over both short and long time periods as well. During this unit, we are going to learn about several important weather observations, we are going to go outside and do some actual observations, then we are going to compare some of what we measure to measurements taken at an automated weather station.

(4,5) Weather is defined as the state of the atmosphere at any given time. The current temperature outside, or what it is going to be like tomorrow are examples of weather. As you probably know from experience, weather conditions can change very quickly. Have you ever had to get out of a swimming pool or lake because it suddenly began raining or thundering? Think about a time when the weather affected something you wanted to do. Weather conditions over a longer period of time, **climate**, also affects us, although these effects may not seem as obvious at first. The normal temperature, or average rainfall amount in June, are examples of climate. Florida has a **humid sub-tropical** climate. This means we have hot, humid summers, and dry, chilly winters. Farmers are very interested in climate because of how long-term weather conditions affect their crops. Who else besides farmers may be concerned about climate? Weather and climate play a significant role in everyone's life, whether in the short-term or long-term.

(6) When talking about weather and climate, it is also helpful to talk a little about what the atmosphere is like. Earth's atmosphere extends up from the surface to about 100 km (300,000 ft.), and is made up of several layers. The blue line shows how the temperature changes with height as you go up through the different layers. We live in the *troposphere,* which is the lowest 12 km (35,000 ft.) of the atmosphere. All weather occurs here. In this layer, the temperature normally decreases as you go up. In some layers, however, it increases as you go higher. Airline jets typically fly near the top of the troposphere, but some can fly higher, even into the *stratosphere*.

(7) Let's talk about why it is important to do weather observations in the first place. Weather occurs on many different *scales*. In other words, there are small weather events, such as wind blowing at your house, or heat rising from a parking lot, and there are large weather events, such as a cold front, or a hurricane. It is important to understand how all these different types of events work. We have weather satellites and RADAR to help us understand the large events, but we need people like you to go outside and take observations locally to better understand the smaller ones. The more observations we can make, the better scientists are able to study these events, and the better we can forecast. In other words, more data is *better*!

(8) The Weather Station

To be able to make good, accurate observations of the weather you need a weather station (or shelter): a simple structure that houses your weather instruments. Weather shelters can be very simple, or more complicated, depending on their intended purpose. Pictured is a common weather shelter. It is painted white (why white?…to reflect sunlight) and contains vents on the sides and the door that allow air to circulate through the inside. "Sheltering" the thermometer from external influences provides the best sample of air possible for measurement. The shelter is normally mounted on a post or tripod facing north (why north?...so there is no direct sunlight on the thermometer when open). There are typically two weather instruments on a weather station, a maximum/minimum **thermometer** and a **rain gauge**. Some shelters are much simpler in design, and provide only a "roof" for the thermometer. A shelter like the one in the picture can be purchased or built, but may require some knowledge of construction. Plans for building this type of shelter can be found in the Appendix.

Given that the purpose of the shelter is to provide the thermometer a best-possible sample of air, it should be placed over a natural surface such as grass, soil, or sand, and as far away from buildings as possible--again to minimize external influences on the temperature reading. Also, the rain gauge should be located away from external influences as well. To collect accurate rainfall, you would certainly not want to put the rain gauge under a roof or tree. Also, try to keep it away from fences where rain can splash into the gauge.

(9) Thermometer

Temperature is a very common weather observation. It is defined as the average energy of motion of the air molecules, or how hot or cold the air is. Rub your hands together and see what happens. Do your hands get warmer? This is because the molecules on your skin are moving faster. When you stop, they cool down. Temperature is measured primarily using two scales, Celsius (°C) and Fahrenheit (°F), both of which are named after the scientists that invented them. On the Celsius scale, 0° is the freezing point of water, and 100° is the boiling point. On the Fahrenheit scale, freezing is 32°, and 212° is boiling.

Your weather station will have a maximum/minimum thermometer, commonly called a "U-Tube", because it is shaped like the letter U. You should check your thermometer every 24 hours, preferably at the same time each day.

When you check it, read the current temperature; and the maximum/minimum temperatures that have occurred since you last checked it.

You read the minimum temperature on the left side of the thermometer. As the temperature decreases during the night, the liquid rises up the left side, pushing the indicator. When the minimum temperature is reached, the indicator remains at that point. To read the minimum temperature, read the scale at the *bottom* of the indicator, keeping in mind that the scale *decreases* as you go up. As the temperature increases during the day, the liquid rises up the right side, pushing the indictor. When the maximum temperature is reached, the indicator remains at that point. The maximum temperature is read in much the same way, but on the right side of the thermometer. Remember to read the *bottom* of the indicator, but keep in the mind the scale *increases* on the right (like a normal thermometer). The current temperature is simply read at the top of the liquid, and can be read *on either side* of the thermometer. When you finish, reset the maximum/minimum indicators for the next time period by either pressing a button on the thermometer, or using a magnet to "drag" the indicators back to the top of the liquid.

(10-12) Rain Gauge

Rainfall is another very common weather measurement. It is one of the simplest, yet one of the most important. Rainfall can be highly variable. Living in Florida, you know that it can be raining at your house, but completely dry at your neighbor's house. Temperature is not going to change from one house to the next, but rainfall certainly can. Therefore, it is an essential part of any weather observation. And the more rainfall observations collected, the better. Remember *more data is better*? This applies to rainfall, for sure.

A rain gauge is simply a narrow tube with a wide funnel at the top, and a scale on the side, like the one shown in the picture. The wide funnel collects falling rain, and directs it into the narrow tube, where it is measured with the scale. Rainfall amount is usually measured in inches. The narrow tube holds a total of 1 inch of rainfall. If more than 1 inch of rain falls, it overflows into the larger tube, which can hold up to 10 inches of rainfall.

Measuring rainfall amount is very simple. Simply read the scale next to the amount of rain collected in the inner tube of the gauge to the nearest *hundredth of an inch*. Each increment on the scale represents 1 hundredth. Also, be sure to measure at the bottom of the "meniscus", or curved shape. If the inner tube is full, and rain has collected in the outer tube, you'll have to do a little extra work, but not too much. First of all, the rain collected in the inner tube totals 1 inch, so write that amount down on a piece of paper, or your data journal. Then, pour that water out. Next, remove the funnel and place it in the inner tube. Now, pour the water from the outer tube into the inner tube. If it fills up, write down another 1 inch on your paper. Repeat this process, writing down each amount measured, until all the water has been poured into the inner tube. Then, simply add all the numbers you wrote down for a total amount collected.

(13-15) Clouds

Clouds are also a very common, and easy, observation. In fact, you already have the instrument needed to observe clouds…your eyes! That's all you need. Clouds can tell us a lot about what is happening with the weather. In fact, some of the early meteorologists used changes in the clouds to make weather forecasts. Have you ever seen a halo around the sun or moon? That is normally a sign that a weather front is approaching. Pretty neat, huh? All that just by looking at clouds! Clouds can simply be fun to watch. Clouds are classified by their shape, height, and whether or not they produce rain. Part of the name of a cloud tells you something about the shape, the other part tells you how high it is, and another part can tell you whether it is producing rain or not. You will learn about the different cloud types and when you do your observations, you will write down the types you see.

In this picture is the GLOBE Cloud Triangle, a diagram that shows how clouds are classified. Notice at each corner of the triangle are the parts of the name associated with the shape of the cloud. A **stratus**-type cloud is layered, a **cirrus**-type cloud looks like strands of hair (NOTE: cirrus clouds are made of ice crystals so are also classified as high clouds), and a **cumulus**-type cloud is puffy, like cotton. Moving up the sides of the triangle from the bottom, combine the shape and height of the cloud to form its name. An **altostratus** cloud, for example, is a layered, middle (alto means middle) cloud, and so on. Across the bottom of the triangle are the 2 types of clouds that produce rain, **nimbostratus**, and **cumulonimbus**. These clouds are across the bottom because their bases are low, even though the tops of a cumulonimbus cloud can reach high into the atmosphere, sometimes as high as 50,000 ft!

In addition to identifying the cloud types, we can estimate the *cloud cover*, or how much of the sky is covered with clouds. There is no way to calculate or measure the amount of cloud cover, like you measure temperature with a thermometer, for example. It is only an estimate. Therefore, it is OK if your estimate differs from someone else's.

It is very simple to observe cloud cover, No clouds in the sky means just that: no clouds. If you estimate 0-10% of the sky is covered, it is said to be *Clear*, 10-25%, the coverage is said to be *Isolated*. A **scattered** sky is covered 25-50%, a **Broken** sky 50-90%, and finally, an **Overcast** sky is greater than 90% covered. That's it. Observing clouds is that simple, and can be a lot of fun.

Activities:

(16) Let's Go Outside!

Now that we have reviewed all the basics of taking weather observations, let's go out and actually do it, which should be a lot more fun than learning about it. You will need to take several items with you outside. Be sure to bring a data entry sheet, or "journal", a National Weather Service (NWS) cloud chart, a pencil or pen, and most importantly, your eyes!. The journal and cloud chart can be found in the Appendix. Before going outside, complete the top of your data entry sheet with the date, time, and names of the observers in your group (if you are doing them as a group).

CONDUCTING OBSERVATIONS

Now, as we discussed earlier, a very important aspect of taking weather observations is where to place your weather station. To determine whether this is really important or not, we are going to do a little experiment while outside. We are going to take observations at shelters in two different locations to see how they can differ. When you get outside, notice where the shelters are placed. Are they in the open or near a building? Are they on a natural surface such as grass or sand, or are they on pavement or concrete? Chances are that your readings will be somewhat different.

As we mentioned before, we are going to observe several parameters. It doesn't really matter which observation you take first, so we'll start with temperature.

Before you take any observations, **pick one of the shelters**. It does not matter which shelter you visit first, but make note of the location in the margin (i.e., Site 1 - near building or tree, on grass, on pavement, etc.).

Shelter Discussion: While outside with the students, discuss the importance of proper instrument citing how minimizing external influences is crucial to accurate data. Identify less-than-ideal locations and point out why those might not be desirable locations.

I. Temperature

a) Read the maximum and minimum temperature remembering to read the values at the bottom of the indicator (NOTE: these values will be valid only for the period of time since the thermometer was placed outside. Ideally, the maximum/minimum temperature recorded represents the previous 24-hour period), and write this value down on your data entry page. *Remember that the scale decreases on the left side of the thermometer and increases on the right.*

b) Read the current temperature, remembering to read the value at the top of the liquid (you can read either the left or right scale for current temperature, just remember to read the scale properly), and write this down on your data sheet.

c) Reset the maximum/minimum temperature indicator.

II. Rainfall Amount

a) Read the scale on the rain gauge at the bottom of the meniscus to the closest .01 inches (remember each increment is .01 inches).

b) If the inner-tube is full and rain has collected in the outer-tube:
-**Write down 1 in. on your sheet** in the margin (remember the inner-tube holds a total of 1 inch), then discard that water.

c) Using the funnel, pour water from the outer-tube into the inner-tube. If the inner-tube fills, record 1 inch again on your sheet. Repeat this process until all rainfall has been measured.

d) Add all amounts recorded from the inner-tube to obtain the total amount collected in the rain gauge.

e) Record amount on your data sheet.

III. Cloud Type

a) Relocate, if needed, to an area with an open view of the sky (it is not necessary to view cloud types beside shelter - relocating to a place where you can see the most sky is best).

b) View the sky in all directions (for simplicity, start looking toward the north, then in the other cardinal directions [E, S, W] until you arrive back at north), **using your NWS cloud chart to identify any cloud types you see**.

c) As you identify cloud types, place a check mark beside the cloud type name (remember, there can be several types present at one time, so check as many as you observe) **on your data entry sheet**.

IV. Cloud Cover

a) View the sky in all directions (as you did for *cloud type*).

b) Estimate how much of the sky is covered with clouds using the categories on your data sheet. Remember cloud cover is subjective so individual estimates may vary.

c) Check the appropriate category on your data sheet.

V. Comments

During your observation, you may observe something that is outside the choices on your data sheet. If so, you can make a comment about what you observed. In fact, official weather observations used by the National Weather Service include *Comments* sections as well so their weather observers can do the same. For example, while observing clouds, you may see a forest fire in the distance. If you were a real weather observer, this would be very important, and you would want to record it. Also, something unexpected might happen to an instrument that would prevent an accurate reading - an obstruction in the rain gauge, for example. A comment can be any extra information about your observation you believe is important; there are no wrong comments.

Congratulations! You have completed a real weather observation. Make sure you have maximum, minimum, and current temperatures from both sites, rainfall amount from both, cloud type, cloud cover, and any needed comments recorded on your data sheet.

Now, take some time to find out what everyone recorded, and compare temperature from your two sites. Look at the readings and relate them to the location of each site. At which site was the temperature the highest? Does this make sense given the location? What about clouds? Did everyone identify the same cloud types? What about cloud cover? Chances are that there were some differences in cloud cover-- remember this is a subjective exercise.

VI. Automated Weather Observation Comparison

Now that we have taken some manual observations, let's look at some observations from an automated weather site. An automated site does not require human intervention; all the instruments take measurements automatically, then typically send them to a computer, or store them on a "data logger" - a data storage device that can store a large number of observations. The Florida Automated Weather Network (FAWN) is a network of automated weather stations. FAWN sites measure temperature and rainfall amount, just like you did today, as well as several other parameters.

a) Direct your browser to the FAWN website at http://fawn.ifas.ufl.edu. On this page, you see a map of Florida with a bunch of numbers on it. Each of these numbers represents a FAWN site location and the temperature in degrees Fahrenheit at that FAWN site.

b) Find the FAWN site nearest your current location.

c) Click your mouse on that site. You will notice a picture of a FAWN tower, with the current measurements from that site surrounding the tower.

d) Notice some of the other parameters measured at a FAWN site that you did not measure at your site.

e) Now, how does the temperature from your most ideal site compare to the one at the nearest FAWN site?

f) Back on the home page, click on Database

- **Click on Report Generator.**
- **Under Locations (check all that apply) select three different sites that vary in Geographic location throughout the State of Florida.**
- **Under Report Type select Monthly Avgs.**
- **Under Date Range select one month prior to current date and the current date.**
- **Under Measurements Select Temperature and Rainfall.**
- **Generate Report as HTML table.**

Discussion Questions:

What are the differences between your selected site's temperature and rainfall?
What could cause those differences?
What are the differences between months?
Has something occurred to cause those differences besides natural weather cycles?

Discussion Questions: (numbers in parenthesis correlate with power point slide, and can be used during power point or after for review)

(3) How does weather affect us? Plants?
(4,5) When has weather influenced you or your activities?
(4,5) Who else besides farmers may be concerned about climate?
(8) Why do you think it is painted white?
(8) Can you think of any areas that would negatively influence the thermometer or rain gauge?
(9) Why should you check your temperature at the same time everyday?