

Equipment and Measurements



Activity Basics

Topic: Precipitation

Level: Any

Time: 1 class period

Purpose

Students will be introduced to a national study in which they will learn to read and collect precipitation data. As participants in CoCoRaHS, students will learn how to use and read rain gauges, as well as how to collect precipitation measurements using different tools.

Overview

While learning how to collect precipitation data, students will use mathematical skills, learn about the importance of taking multiple measurements and explore the difficulties scientists may encounter while gathering scientific data in the field.

Student Outcomes

Students will be able to:

- Collect precipitation measurements of either rain or snow using the rain gauge.
- Gain knowledge of the importance of taking multiple measurements while collecting quantitative scientific data.
- Use mathematical skills in order to read and record data for the study.
- Infer difficulties scientists may come across while gathering scientific data in the field.

Science Standards

National Science Standards:

- A: Scientific Inquiry
- D: Changes in Earth and sky
- E: Science and Technology

Colorado State Standards:

- Science Standard 2.3.1 (weather impacts the environment)
- Science Standard 5.3.3 (weather conditions change over time)
- Science Standard 6.3.2 (circulation of water)

Climate Literacy Principles:

- Principle 1 (Sun is the primary source of energy for Earth's climate system)
- Principle 5 (Improved understanding through observations)

Time

Approximately one 45 minute class period.

Level

Primary, but can be scaled up or down to accommodate other grade levels.

Materials

- Official CoCoRaHS rain gauge
- Ruler with 1/10th inch markings
- Container full of water and sponge
- Water proof cover, such as a tarp to put on the table/desk used for the demonstration.
- Student notebooks

Background

On planet Earth, all life depends on water, and our sun is the primary source of energy that fuels the water cycle throughout our atmosphere and land. In this cycle, water evaporates from the land and oceans — up into the atmosphere. Then it falls back to the surface as precipitation, and finally returns to the sea (via rivers and streams on the surface as well as underground).

Precipitation refers to all forms of liquid or solid water that falls from the atmosphere to the earth. Liquid precipitation falls as either rain or drizzle while solid precipitation falls as either snow, ice pellets or hail.



Have you ever seen it rain on one side of the street and not the other? Or different amounts from one side of the city to the other? Precipitation is so variable, it can sometimes fall in short bursts, or drench an entire area. It is important to know how much rain falls at different locations, and it simply can't be done by radars and satellites alone. Scientists at the National Weather Service (NWS) provide weather data to the media, farmers, city water/flood managers and countless others who need to know how much precipitation fell at their location. Weather-watchers like you can help meteorologists and climatologists who are trying to improve their techniques of understanding and predicting weather events. Volunteers with rain gauges are a vital piece of the puzzle,

as these observations can be compared to satellite and radar data. Each technique – rain gauge, satellite sensors, and radar – measures something different about the rain and has different limitations. So, comparing these different types of data can provide a more accurate picture of how much precipitation actually occurred over an area.

Climate scientists look for longer-term patterns in the data. Instead of studying the weather which focuses on the current day, climatologists study the long-term picture. Mark Twain once said, ‘the climate is what you expect, the weather is what you get’. As an example, right now, you can probably take a guess as to what you will be wearing next December 21st...or June 21st. However, when that day comes, the weather may be something totally different that what you would have expected.

A climate scientist may ask; What regions are the wettest? How little rain falls in deserts? What are the patterns of rainfall during the year? Climate scientists are particularly interested in how the total amounts and patterns of precipitation change over the years. Are rain events becoming more numerous? Are storms producing larger amounts of precipitation on average? Is the timing of rain during the year shifting?

To know how much fell, we use gauges to measure. Measuring rain is quite simple.

Snow is more difficult to measure, mostly for the simple fact that snow has a tendency to melt, compact or blow around. It may be difficult to determine the best place to take a measurement due to drifts and blowing snow. Did any of it melt before we measured it? Furthermore, the amount of liquid water in the snow is never the same. Have you ever tried to shovel snow and could barely lift it up? Other times, you may have experienced fluffy, extremely light snow. This is due to the ‘Snow Water Equivalent’ (called SWE), or the amount of water contained in the snow.

Simple depth measurements of snow can be taken with a ruler, but in order to measure the water content, the snow must be melted before the SWE can be determined.

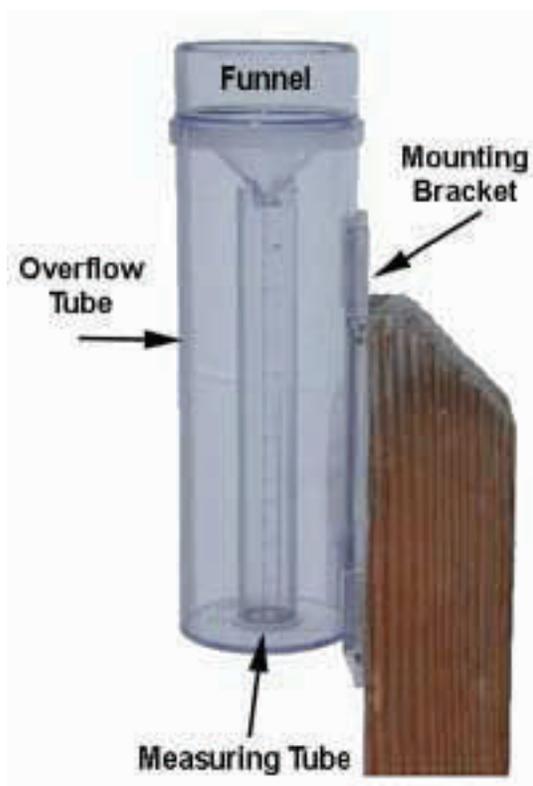
As CoCoRaHS participants, you are well on your way towards helping scientists by contributing your own precipitation data.

In this lesson, students will learn how a rain gauge works and how to record accurate measurements of rainfall, snow, and the amount of water contained in the snow.

The National Weather Service has been tracking precipitation to an accuracy of 1/100th of an inch for many decades. In order for the data to be acceptable, we must use instrumentation that measures to the same degree of accuracy.

While the CoCoRaHS rain gauge is a smaller,

less expensive version than the National Weather Service uses, it still provides an accuracy to the 1/100th of an inch, and has been proven to be acceptable.



Preparation

Before teaching this lesson, it would be beneficial to complete a basic training course in observing and reporting precipitation. You can complete this at <http://www.cocorahs.org>, or with a CoCoRaHS mentor. Make sure all materials are completely organized for the lesson to go smoothly.

- The rain gauge has three pieces; the outer tube, inner tube, and funnel.

- In order to be accurate (within 1/100th of an inch), the funnel and inner tube are designed to magnify the first inch that falls into the gauge.
- One inch of rain will fill the inner tube to the top (1.00 mark). This way, rainfall (or the liquid equivalent from snowfall) can be accurately measured to the nearest 1/100th of an inch. Amounts greater than 1 inch will overflow into the outer tube.
- This is the standard maintained by the National Weather Service.

Prerequisites

Students should have basic knowledge of fractions, how to read measurements, and basic computer skills.

What to do and How to do it

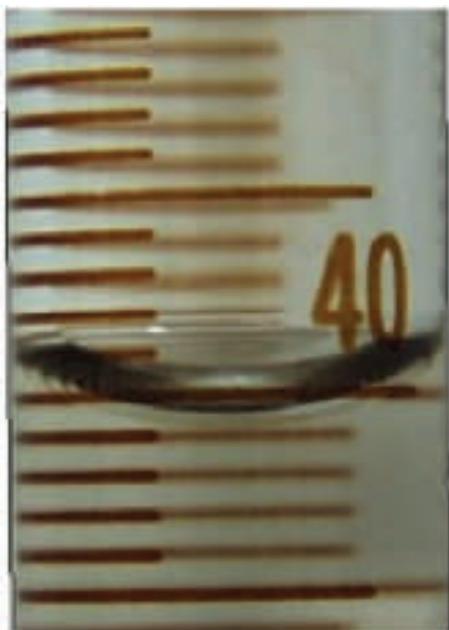
Engage

1. Create a rain storm; In order to engage the students, this section will include a brief simulation of a “rainstorm.”
2. Lay a tarp across a table, or in an area that is easily visible to the students. Place the CoCoRaHS rain gauge on the table over the tarp and use a sponge to splash and drain water into the top of the gauge. It may be fun to include the students in this activity by having them add sound

effects to the demonstration, such as thunder and lightning. A coordinated effort can be done, with a great example here:

http://www.youtube.com/watch?v=9_S6h19czzY

3. Now that the students know what the gauge is used for, remove the inner tube and funnel—leaving just the outer tube by itself.
4. Pour less than 1 inch into the gauge and hold a ruler either next to, or inside the gauge. As you pass it around, ask the students to try to measure or estimate how much is in there. Can they be accurate?
5. Next, using the funnel, carefully pour the water into the inner tube and now pass it around. Can the students accurately measure the water to the nearest 1/100th of an inch?



Make sure to measure from the bottom of the meniscus!!!

Explore

Now that the students understand how to read the rain gauge, we will explain how to use the gauge to measure snow, or more accurately, the amount of water found in the snow. This is called ‘SWE’ (pronounced like ‘Sweet’ but without the ‘T’), or Snow Water Equivalent.

1. First discuss the difficulties with measuring snow. The main problem is that snow can melt, settle or blow around, so determining the best representative location to record your measurement may be challenging. You may need to collect multiple measurements and average them in order to get an accurate reading.
2. Snow is measured two ways; the depth (accurate to 1/10th inch) and the amount of water in the snow.
3. Measure the depth with your ruler. Again, multiple readings and averaging them usually works best.
4. Once you have determined the best representative location, use the outer tube of your gauge and, turning it upside-down, push it into the snow to collect a core sample to bring inside.
5. Allow time for the snow to melt, and then use the funnel and inner tube to pour and

measure the amount of water found in the core sample. To speed up this process, you can add a pre-measured amount of warm water (using the inner tube) to the snow and then measure the amount of melted water in the gauge. Make sure to subtract out the amount of warm water you added though!!

Explore/Explain

1. Ask the students to think about how to measure more than one inch. The inner tube is one inch to the top, but if you get more, and it overflows, work with the class on how to measure more.
2. The class should discover that the solution is to pour out the first inch, and then proceed to pour the overflow amount into the inner tube—adding up each amount as you empty the outer tube.
3. If extra time allows, try to predict the total amount that the gauge will hold, and then test it out.
4. Ask the students questions, or encourage them to tell some of their own weather stories that they have experienced. What is the most rain you think you ever got? What happened during or after the storm? Have you ever experienced a hurricane?



Elaborate

Further questions to investigate:

Break the class into smaller groups and have them answer the following questions.

1. When does your area get precipitation? Why?
2. What if your area only got half the normal amount of precipitation in a given year? How would the effects vary depending on when this precipitation fell?
3. What if you got double the normal amount of precipitation in a given year? How would the effects vary depending on when this precipitation fell?
4. Is the amount of precipitation you get at your school different from the amount at other schools or locations?
5. Where do rain and snow storms come from before reaching your area?

Evaluate

1. After the discussion is complete, students will come back together as an entire class, and participate in a brief class discussion.
2. Ask the students open-ended questions, such as: Why is it important to measure precipitation to the nearest 1/100th of an inch? (This is the degree of accuracy that the National Weather Service ac-

cepts.) Why do you think we need to take multiple snowfall measurements to gain an accurate reading?

3. What could happen that would create a 'bad reading'? (heavy rain/ hail can bounce out, dropping the gauge, strong wind, poor vision) How can our contribution of rain data help meteorologists around the nation? River/Flood managers? Mosquito control?
4. These questions can be answered orally, on a piece of paper, or both if chosen to do so.
5. If teacher instructs to do so, students should write down their own answers in a couple sentences (2-3), and hand it to the teacher as a ticket to leave the class.

Assessment

Formative: Group discussion held throughout the lesson as well as full participation in Q/A or telling of weather stories.

Summative: Science journal/written documents of their answers and predictions that are required throughout the lesson.

Anticipated misconceptions / alternative conceptions:

- A storm produces a uniform amount of precipitation—every time. This is not the case, as precipitation from most storms varies widely from place to place.
- Students may not understand how the measurements work on the rain gauge, as it may be difficult for them to grasp the concept of the inner tube magnifying the first inch of precipitation in the gauge.

Accommodations / modifications of activity for any special needs students

(special education, ELL, and gifted/talented)

This lesson can be modified according to your class needs; however here are a few suggestions.

- For gifted/talented students, have them answer more critical questions in their science notebook during the evaluate section of the lesson. You can also divide the students up during the discussion period and give them a specific role within the group to push their critical thinking skills.
- For special needs students, assist them with measurements and create a handout that has clear cut questions for them to answer throughout the stages. You can

also pair these students up with other students they work well with for the discussion.

- For ELL students, use diagrams and pictures in order to avoid overloading them with words. It's best for these students to have pictures accompanying words so they aren't spending all their energy deciphering the assignment.

Credits, Resources and Definitions

Meniscus: The curved upper surface of a liquid in a tube.

Portions of this lesson plan have been adapted from 'The GLOBE Program':

www.globe.gov

National Science Education Standards:

http://www.education.ne.gov/science/Documents/National_Science_Standardspdf.pdf

Colorado Science Standards:

<http://www.cde.state.co.us/scripts/allstandards/COStandards.asp?stid=7&stid2=0&glid2=0>

Climate Literacy: The Essential Principles of Climate Science:

http://climate.noaa.gov/index.jsp?pg=/education/edu_index.jsp&edu=literacy