Precipitation Patterns Across the Globe

Setting the Stage

The students will apply their knowledge of the water cycle to investigate how annual precipitation patterns are related to geography and biology. Students will guess the location in the world that is associated with the precipitation/temperature records and demarcate the location on a world map. Students will also make predictions as to the type of ecosystem, as well as the types of plants and animals, associated with the precipitation/temperature records. This lesson, as written, assumes students understand the reason for seasons, and how seasons vary between the northern and southern hemispheres.

Rain Cloud Photo credit: State Farm

Activity Overview

Students investigate precipitation patterns across the globe.

- *Part 1 – Engage (15 minutes) Introducing The Water Cycle*
  Students are reminded of the components of the water cycle, and then turn their attention to the different forms of precipitation.
- *Part 2 – Explore & Explain (30 minutes) Analyzing Precipitation and Temperature Patterns*
  Students analyze temperature and precipitation data to determine the locations from which the data was collected. They connect this data to the types of plants and animals found in those locations.
- *Part 3 – Extend (30 minutes) The Water Cycle Around the World*
  Students create a model of the water cycle for one of the locations in Part 2.

Instructional Overview	
Grade Level	Grades 3-5 *(adjustments may be needed)*
Instructional Time	75 minutes *(total time needed)*
NGSS Standards Alignment	Performance Expectation: 3-ESS-2: Obtain and combine information to describe climates in different regions of the world.
Driving Question	Why is precipitation important for people and other living things?
Learning Goals	● Students are able to analyze monthly precipitation and temperature records. ● Students connect the types of plants and animals that live in a location based on the precipitation received by that location.
Materials	● Monthly Precipitation and Temperature Records for 4-6 different locations ○ These can be downloaded at http://www.worldclimate.com/ ○ Alternatively you could use the records for the 6 locations (Boulder, CO; Seattle, WA; Death Valley, CA; Dhaka, Bangladesh; Manaus, Brail (Amazon Rainforest); McMurdo Station, Antarctica) included at the end of this lesson plan. ● Copies of the world map, questions, and data charts for each student or group. ● Slide deck with world map, data charts, and questions.
Material Preparation	❏ Print copies of the world map, the questions, and the data bar charts for each student or student group.
Vocabulary	The water cycle is the circulation of the earth's water, in which water evaporates from the sea into the atmosphere, where it condenses and falls as rain or snow, returning to the sea by rivers or returning to the atmosphere by evapotranspiration. Precipitation is falling products of condensation in the atmosphere, as rain, snow, or hail. Condensation is the process by which atmospheric water vapor liquefies to form fog, clouds, or the like, or solidifies to form snow or hail.

	Evaporation is the change from a liquid or solid state into vapor; pass off in vapor. Transpiration is the passage of water through a plant from the roots through the vascular system to the atmosphere. Surface runoff is water, from rain, snowmelt, or other sources, that flows over the land surface. A rain gauge is a device for collecting and measuring the amount of rain which falls

Activities	**Web Links for Lesson Resources** Note: all resources are downloaded as pdfs in the *Activity Resources Folder*
Activity 2	Data Source: World Climate http://www.worldclimate.com/

Background Information:

The Water Cycle

There are 5 main processes involved in the water cycle: precipitation, condensation, evaporation/transpiration, surface runoff and accumulation/storage. Figure 1 below illustrates these main processes.

Precipitation

Precipitation describes the different forms of water that originate in the atmosphere and fall onto land and water surfaces. Forms of precipitation include rain, hail, snow, sleet, and graupel. However, for the purposes of this lesson we will focus on rain and snow.

Measuring Precipitation

Precipitation is measured with a rain gauge. Rain gauges measure all types of precipitation even though it is called a "rain gauge." Precipitation is collected in the rain gauge, and the amount of precipitation received within the collection period (usually 1 day) is read in the measuring tube. In the United States, precipitation is recorded in inches of rain. For more information on rain gauges and collecting precipitation data please visit the Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS) website: http://www.cocorahs.org

Precipitation records are useful for many different people. Scientists called climatologists use precipitation records to study the climate history of regions throughout the world and to evaluate the likelihood of changes in precipitation patterns such as periods of drought or flood. Scientists called hydrologists use precipitation records to estimate the amount of water that is stored in reservoirs, lakes, and groundwater. Governments rely on the hydrologist's water storage estimates for regulating water use in their municipality. Farmers use precipitation records to decide when they should plant specific crops or how much water they will need for irrigating their crops.

Precipitation data is reported over a variety of time scales. The most common time scales used for reporting are daily, monthly, and annual precipitation. Whereas some precipitation data collection differentiates between the type of precipitation received (e.g., rain, snow, hail), other records only report the amount of total precipitation received. In this activity, we will be analyzing total monthly precipitation records that do not differentiate between the different forms of precipitation received. However, using the average monthly temperature data students will be able to guess the type of precipitation different locations received during each month.

References: http://www.worldclimate.com and http://www.cocorahs.org

Part 1 (Engage) Introducing The Water Cycle (15 minutes)

Begin the lesson by asking students if they experienced any parts of the water cycle with their five senses today (see, touch, smell, taste, or hear).

Ask students to sketch the water cycle in their notebooks. After a few minutes, ask them to share their models with a partner and adjust their models to include components that may have been missing.

Share Figure 1 with students, and ask them if there were parts of the water cycle they did not include or included but were not in the figure.

Then, ask them which parts of the water cycle are most prevalent in their geographic area. The response will vary based on where they live.

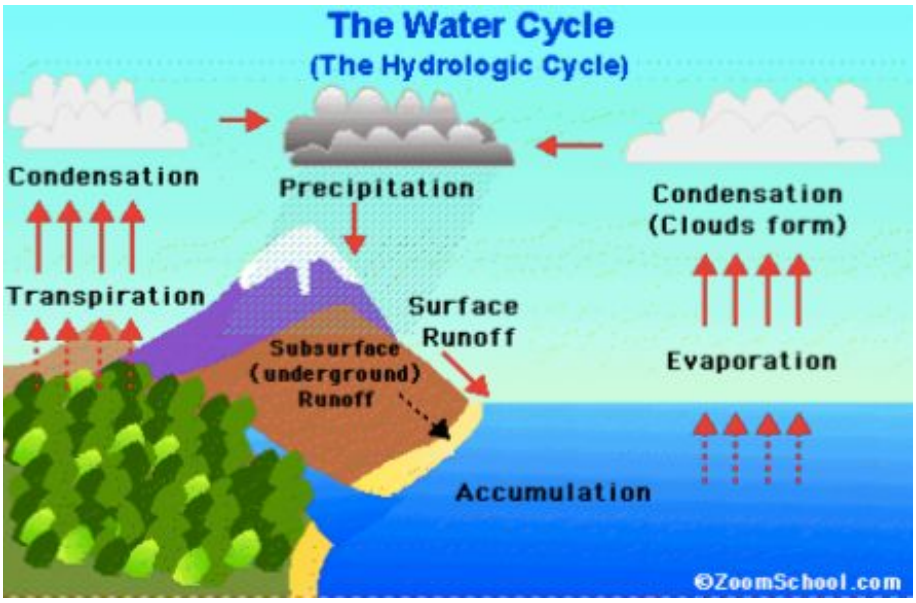


Figure 1: The Water Cycle

Finally, ask students to point to "precipitation" in their water cycle drawing and ask them if there is only one type of precipitation. Once they identify snow, rain, and possibly hail, ask them where they might find variation in types of precipitation. They will likely mention that air temperature controls the type of precipitation. Tell the students that they are going to do an investigation of precipitation patterns across the globe, over the course of an entire year.

Part 2 (Explore & Explain) Analyzing Precipitation and Temperature Patterns (30 minutes)

Each student or group of students should receive:

- A world map.
- A copy of each of the bar charts for the monthly precipitation and temperature records over the course of a year for each location. (Make sure that the location for each record is not included on the bar chart since the main goal of the activity is for the students to guess these locations.)
- A form for students to use to gather their data. (Sample questions are below.)

Ask the students to look at each pair of precipitation and temperature records. Explain that they will be using these graphs to identify aspects of the location where the data was collected. Make sure you point out that the scale on the y-axis (precipitation) varies from graph to graph. Assist students with the metric system if they are unfamiliar with the units in the bar charts.

Some locations may be located in the northern hemisphere and others in the southern hemisphere. If this poses a problem for students who have not yet studied the variation among seasons in the northern and southern hemispheres, consider removing Brazil and Antarctica from the lesson. Another option to assist students as they distinguish between the northern and southern hemispheres, consider asking this question.

> *What type of information might tell you if the location is in the northern hemisphere or the southern hemisphere?*

Remind students that precipitation and temperature information tells them about the seasons, what time of year certain seasons occur, and about the overall climate of a location (e.g., rainy or dry).

Also, you may consider adding your location to the data so students can compare the data from their location to data from other locations around the world.

Allow students approximately 20 minutes to answer the questions and mark the locations on the world map.

After students have completed matching the data with a location, ask them to share their work with a partner if they worked by themselves, or with a group if they worked in pairs. Ask students to share their responses along with their arguments for their responses. Regarding the plants and animals, ask students what adaptations are evident for the survival of the plant or animal for their location.

If possible, consider adding pictures from each location to the slide deck and ask students to match the pictures with the locations based on the plants, animals, and other features they see in the pictures.

Sample Questions:

1. What type of ecosystem or biome belongs with each precipitation/temperature record? (For younger learners, you may want to give students a choice such as - desert, coast, mountain, rainforest. For older learners, ask them to justify their choices.)
   Record 1-
   Record 2-
   Record 3-
   Record 4-
   Record 5-
   Record 6-

2. What types of plants and animals do you think live in this ecosystem? (For older learners, ask them to justify their responses.)

   Record 1-
   Record 2-
   Record 3-
   Record 4-
   Record 5-
   Record 6-

3. Where in the world do you think each precipitation/temperature record belongs? Mark the location on your world map. (For older students, ask them to justify their responses.)

MATERIALS- Data and Bar Charts

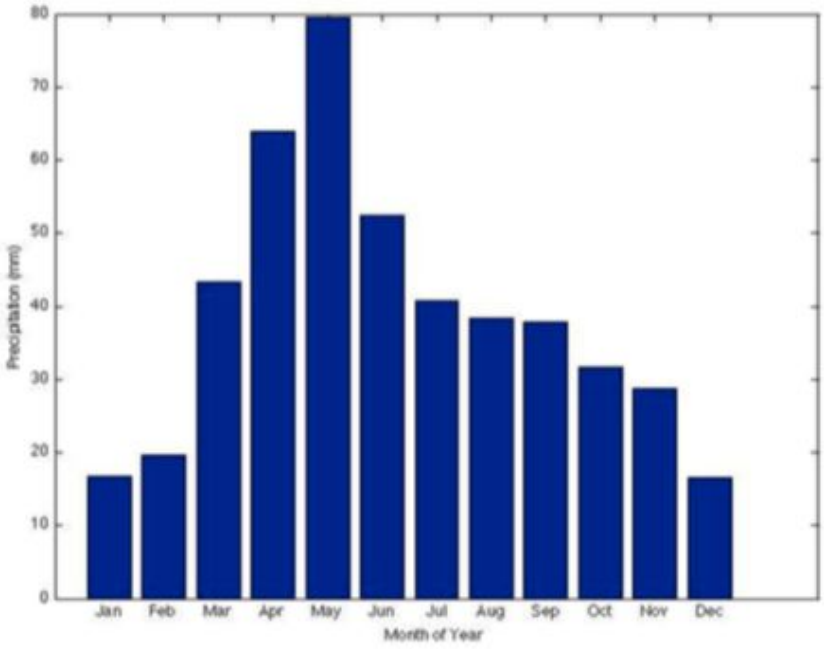
Data

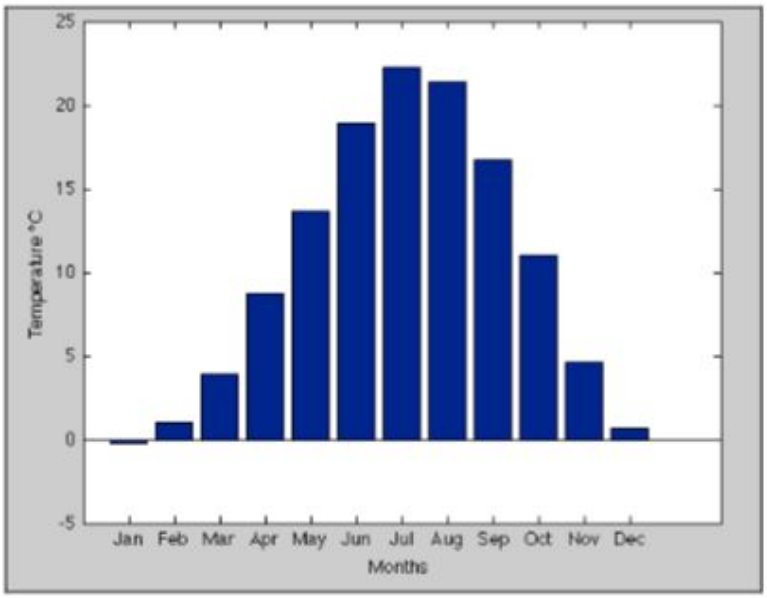
Precipitation (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Boulder, Co	16.8	19.7	43.3	64.0	79.5	52.5	40.7	38.3	37.8	31.7	28.7	16.6
Seattle, WA	124.5	98.8	86.5	56.0	45.3	34.4	15.4	25.9	47.7	82.8	111.2	146.6
Death Valley, CA	6.8	8	5.9	3.3	1.8	0.7	3.1	3.3	3.1	2.4	5	4.6
Dhaka, Bangladesh	8	20.7	58.4	115.7	267.1	357.6	398.9	317.1	256.2	163.7	30	5.8
Manaus, Brazil	263.9	262	297.9	282.7	203.7	103.1	66.9	45.6	63	111.1	161	219.8
McMurdo Station, Antarctica	15	21.2	24.1	18.4	23.7	24.9	15.6	11.3	11.8	9.7	9.5	15.7

Temperature °C	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Boulder, Co	-0.2	1	3.9	8.7	13.6	18.9	22.2	21.4	16.7	11	4.6	0.7
Seattle, WA	3.8	5.6	7	9.1	12.4	15.3	17.5	17.8	15	10.6	6.4	3.7
Death Valley, CA	10.9	15.1	19.2	23.8	29.3	34.7	38.2	37.1	32.2	24.8	16.6	10.4
Dhaka, Bangladesh	18.8	21.6	26.2	28.7	28.8	28.7	28.6	28.7	28.7	27.3	23.7	19.8
Manaus, Brazil	26	26	25.9	26	26.2	26.3	26.5	27.2	27.5	27.5	27.1	26.6
McMurdo Station, Antarctica	-2.9	-9.5	-18.2	-20.7	-21.7	-23	-25.7	-26.1	-24.6	-18.9	-9.7	-3.4

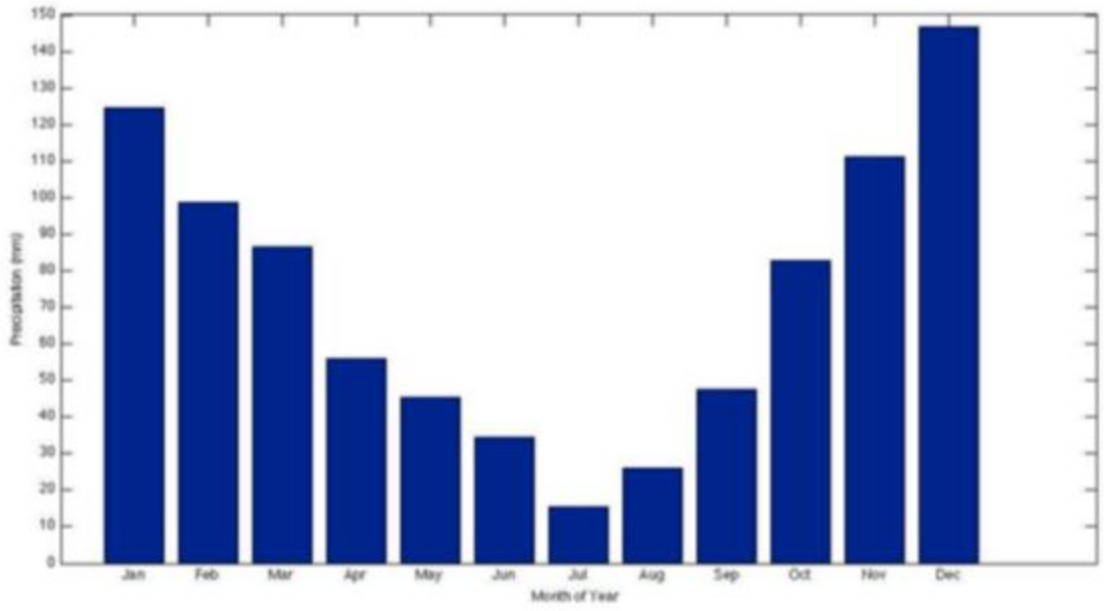
Bar Charts

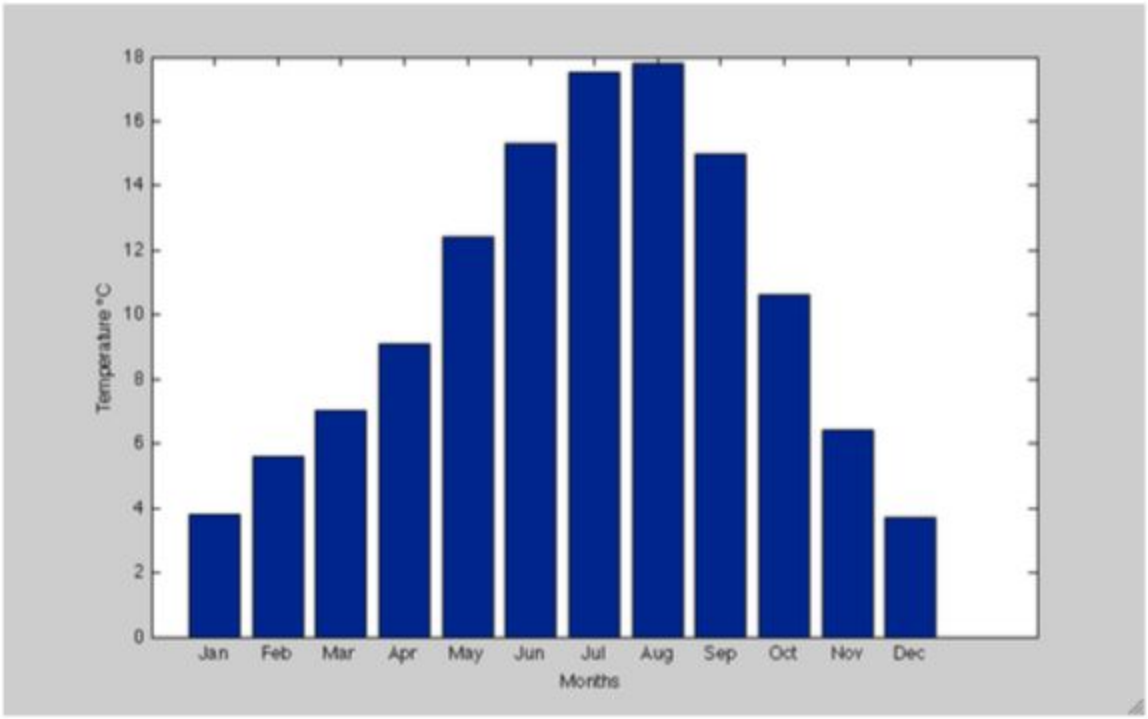
Boulder, CO
Total Annual Precipitation = 469.6mm



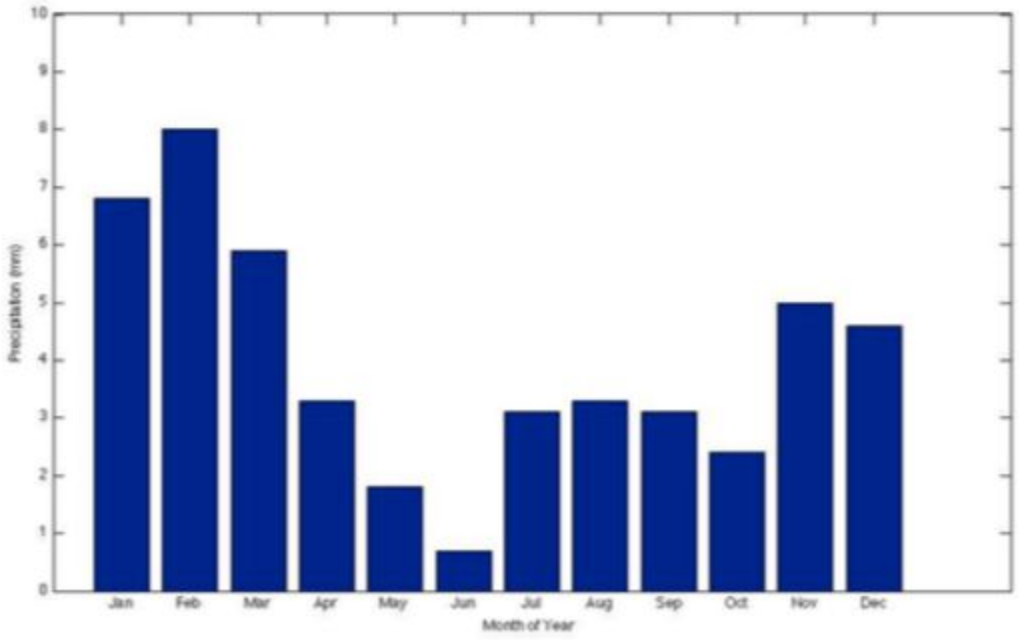


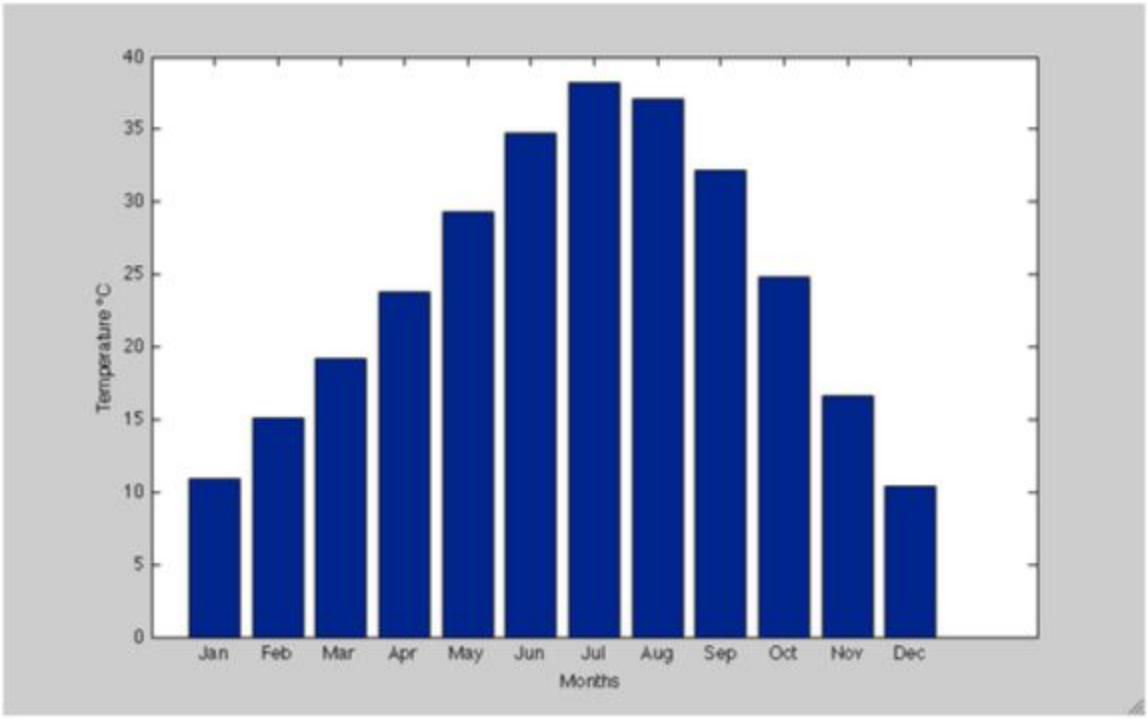
Seattle, WA
Total Annual Precipitation = 875.1 mm



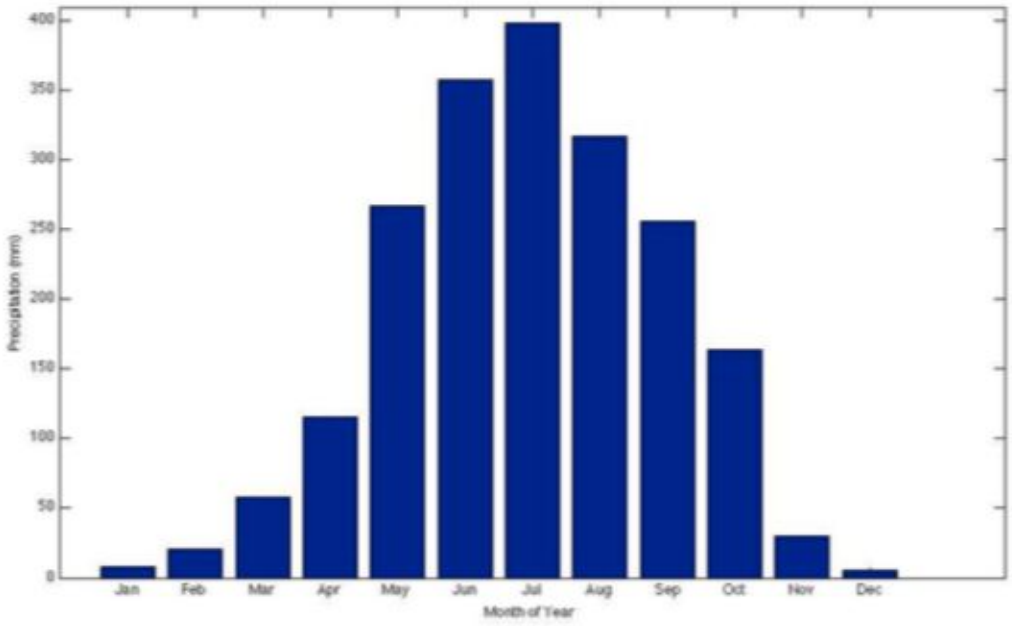


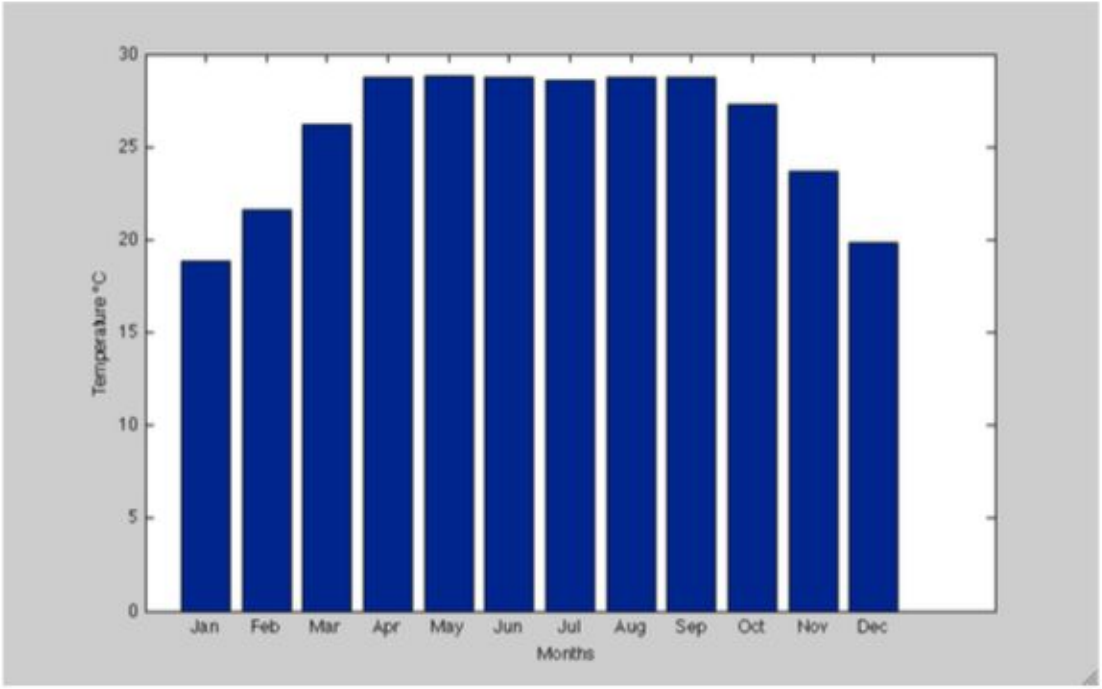
Death Valley, CA
Total Annual Precipitation = 48mm



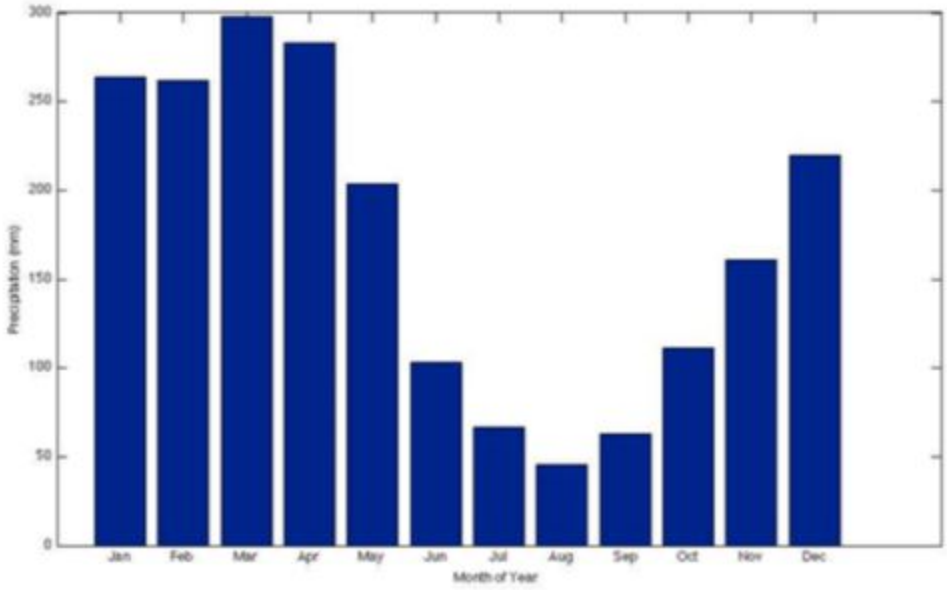


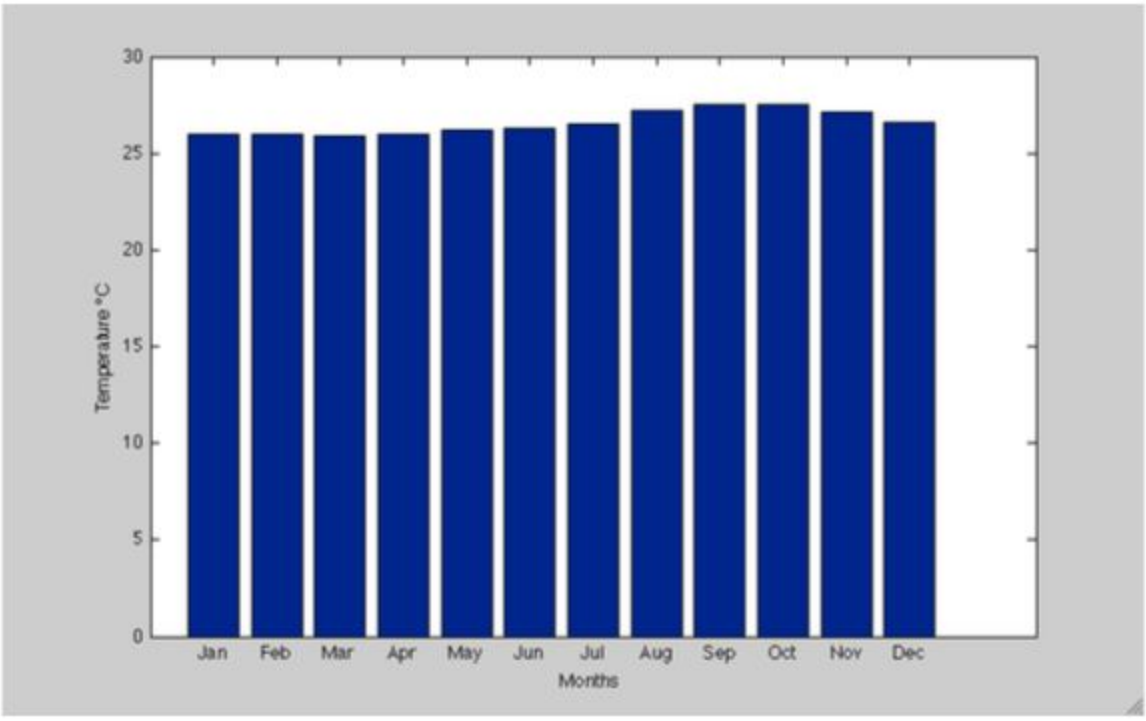
Dhaka, Bangladesh
Total Annual Precipitation = 1999.2mm



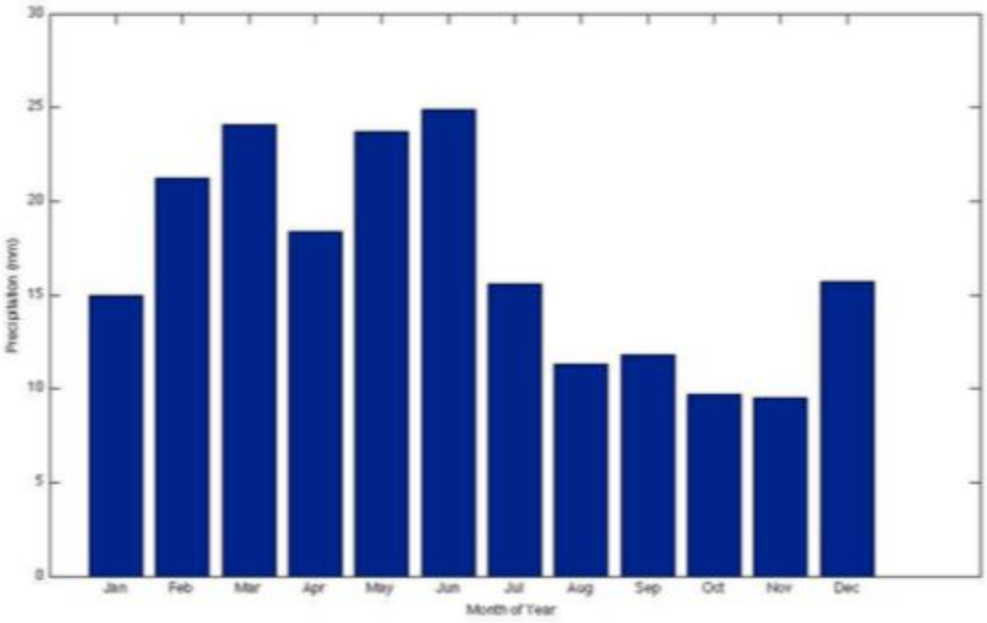


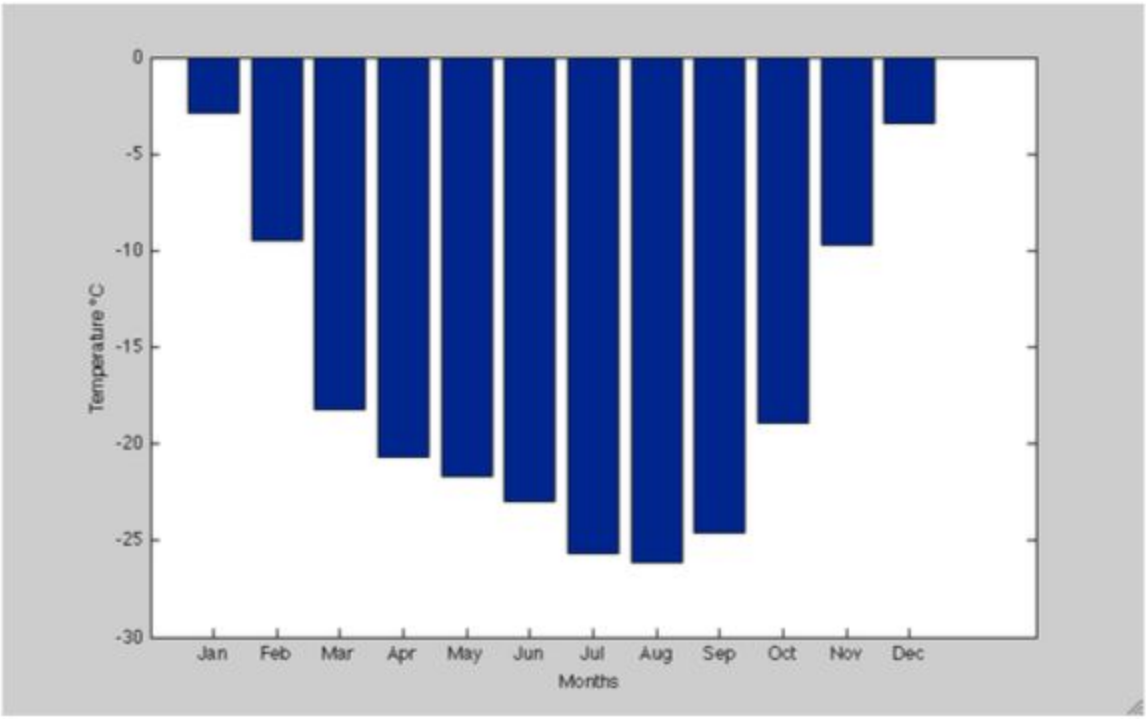
Manaus, Brazil
Total Annual Precipitation = 2080.7



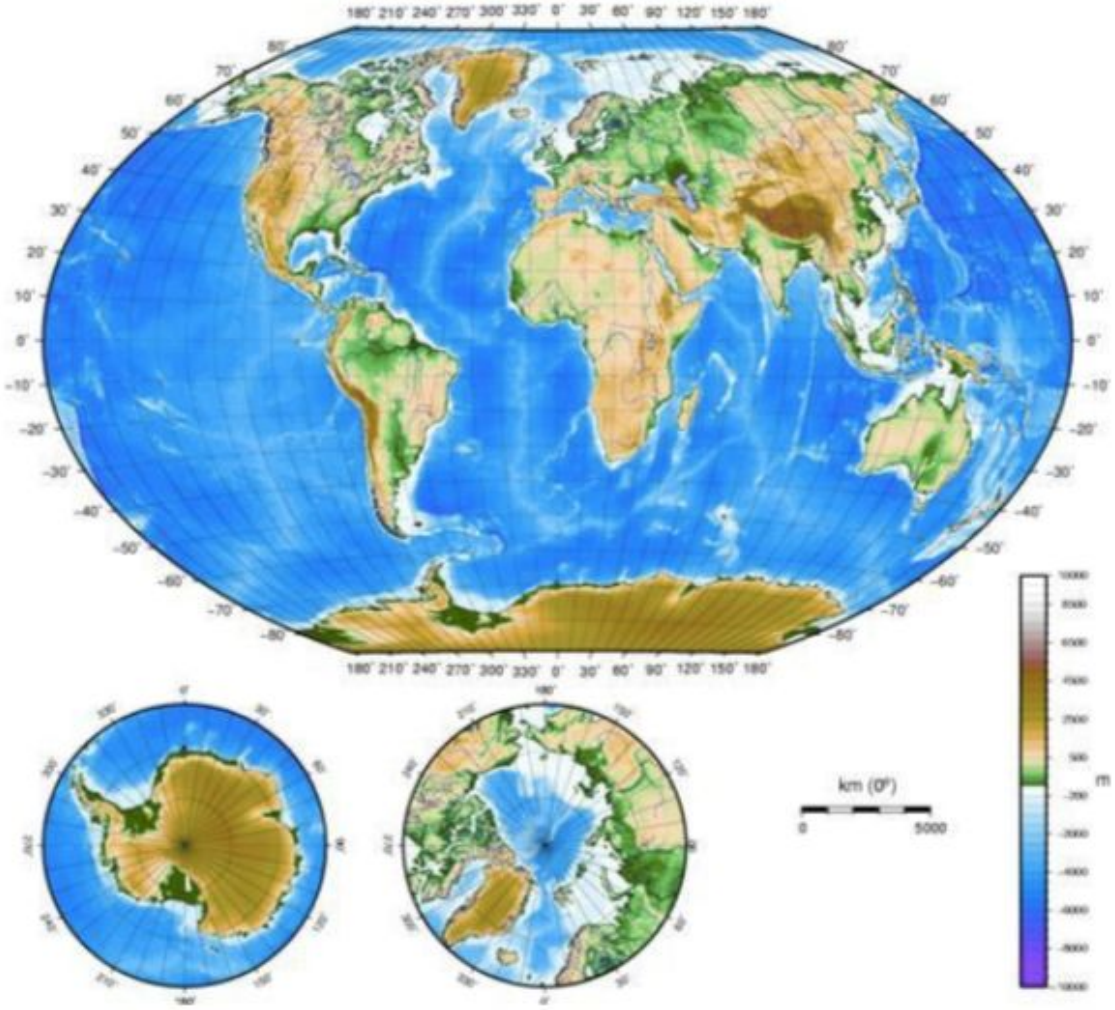


McMurdo Station, Antarctica
Total Annual Precipitation = 200.9mm





WORLD MAP



Part 3 (Elaborate) The water cycle around the world (30 minutes)

Now that students have an idea of the connections among temperature, precipitation, seasons, plants, and animals, they will now reflect on Part 1 of this activity.

Divide students into 6 groups, one for each location in Part 2. Ask them to draw a model of the water cycle for their location. They may need access to a computer to learn a little more about their location. After 15 minutes ask students to share their models, and explain how it is different from the model they drew in Part 1.

To wrap-up the activity, ask students what the role of precipitation is in the water cycle, as well as in climates around the world.