Title: Precipitation Patterns across the Globe

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Type of Lesson: STEM

Grade Level(s): 4th - 7th grade
This activity can be tailored to older, more advanced students by having the students make their own bar charts of the monthly precipitation and temperature data, instead of providing them with bar charts.

Objectives: 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.

Boulder Valley School District Essential Learning(s), 4th grade:

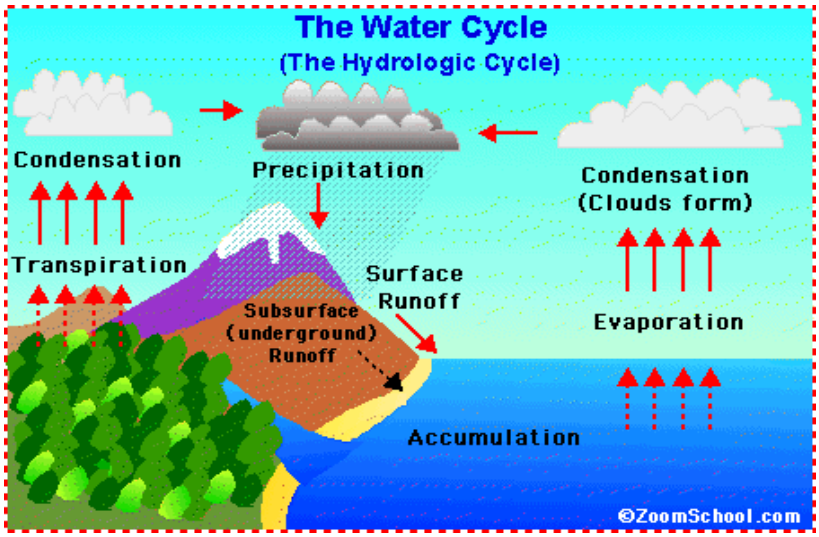
Science Standard 1: Students analyze monthly precipitation and temperature records, displayed in bar charts, collected in metric units (mm).

Science Standard 3: Students predict the types of plants and animals that live in a location based on the precipitation received by that location over the course of a year.

Science Standard 4: Students review the different phases of water in the water cycle, and they use precipitation records to discern which forms of precipitation locations received at different times of year.

Background Information:

The Water Cycle
There are 5 main processes involved in the water cycle: precipitation, condensation, evaporation/transpiration, surface runoff and accumulation/storage. The figure 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 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 following 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 on the date of collection (rain, snow, hail, etc.) 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 the location received during each month.

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

Lesson Vocabulary:

Water Cycle, Precipitation, Condensation, Evaporation, Transpiration, Surface Runoff, Storage, Rain gauge.

Materials Required:

1. 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, Brazil (Amazon Rainforest); McMurdo Station, Antarctica) included at the end of this lesson plan.
2. A world map for each student, or student group, to write on.
3. A copy of the questions that students will answer during the activity (included in the lesson plan).

Preparation:

Print copies of the world map, the handout of the questions for the students to answer, and the precipitation and temperature record bar charts for each student or student group.

Safety Information:

There is no safety information needed for this activity.

Engagement:

Begin the lesson by posing the question, "did you experience any parts of the water cycle with your senses (see, touch, smell, taste, or hear) today?" After a short discussion of this, you can play the following video to remind the students of the important components of the water cycle:
http://www.youtube.com/watch?v=BayExatv8lE
After watching the video, have students draw the water cycle in their science notebooks. Allow students to check their work by showing them a diagram of the water cycle.

Ask students to point to 'precipitation' in their water cycle drawing. Then pose the question, "Is there only one type of precipitation?" Then ask students to raise their hands and mention all of the different kinds of precipitation, and whether the form of precipitation occurs during warm or cold weather.

Next, tell the students that today they are going to do an investigation of precipitation patterns across the globe, over the course of an entire year!

Exploration:

Each student or group of students should receive:

1. A world map.
2. A copy of each of the bar charts for the monthly precipitation and temperature records over the course of a year for each location (my version of the bar charts is included at the end of the lesson plan). 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.
3. A copy of the questions they will answer as a part of this activity.
   The following is a list of the questions, and a sample data sheet is included at the end of this packet:

   1. What type of ecosystem belongs to each precipitation/temperature record? (examples- desert, coast, mountain, rainforest)

   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?

   Record 1-

   Record 2-

   Record 3-

   Record 4-

   Record 5-

   Record 6-

4. Where in the world do you think each precipitation/temperature record belongs? **Mark the location on your world map.**

Ask the students to look at each pair of precipitation and temperature records. Explain that they will be using these graphs to answer the above questions. Make sure you point out that the scale on the y axis (precipitation) varies from graph to graph. Some locations may be located in the northern hemisphere and others in the southern hemisphere. Post the 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, and what time of year certain seasons occur, and about the overall climate of a location (i.e., rainy or dry).

Give students 10-25 minutes to answer the questions and mark the locations on the world map.

Explanation:

Ask a few students or student groups to volunteer their answers for one of the precipitation/temperature records.

Then display the locations for each of the records, and discuss why the location makes sense due to the precipitation/temperature data (i.e. for Death Valley, CA it is very dry and hot). Also discuss the types of plants and animals that may live in the location, and the adaptations the plants and animals might have to their environment.

Extension:

A good extension of this lesson would be for students to create a poster that incorporates the precipitation/temperature information with the ecosystem traits they described for one of the locations.

If time and resources allow, students could select a new location in which they are interested, and conduct research on the average monthly precipitation and temperature in that location. Students could also research the environmental characteristics of that location. Then, the students could create a poster that incorporates all of the information they found during their research.

Evaluation:

An immediate evaluation of the students' understanding would be 1) their answers on the handout for the lesson, and 2) the accuracy of the poster they created during the extension.

Also, the day after the lesson is completed, show the students a picture of an environment. Then ask the students to write a short paragraph in their science notebook

describing the type of precipitation and temperature that location receives, and the types of adaptations the plants and animals have for that location.

Wrap-up:
Discuss, "why is precipitation important for people and other living things?"

HANDOUT

Name:_____

Annual Precipitation Questions

1. What type of environment belongs to the precipitation record?
(examples- desert, coast, mountains, rainforest)

_____

_____

2. What types of plants and animals do you think live in this environment?

_____

_____

3. Where in the world do you think the precipitation record belongs?

***Also, Mark the location on your map.**

_____

MATERIALS- Data and Bar Charts

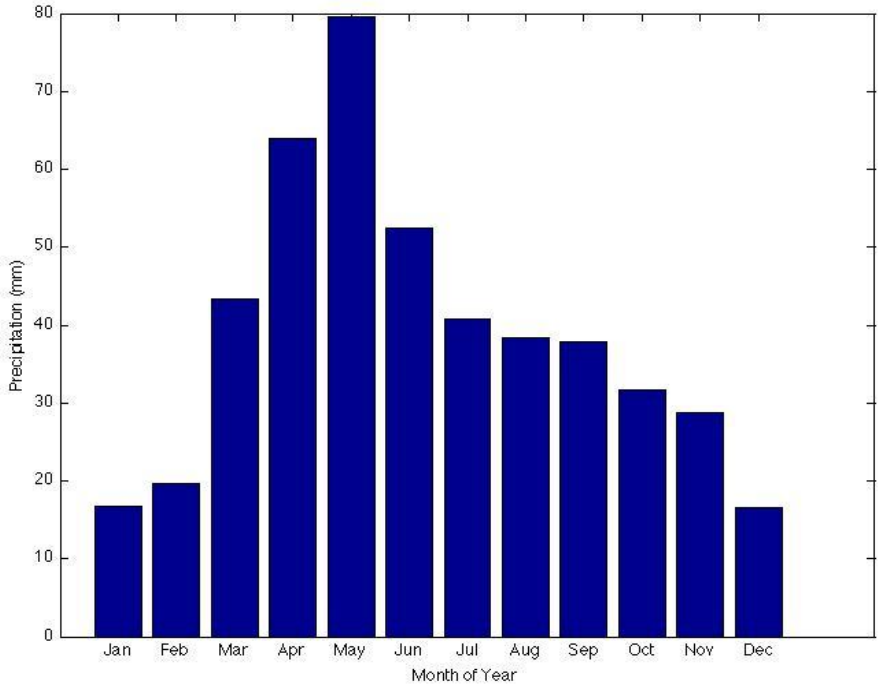
Data

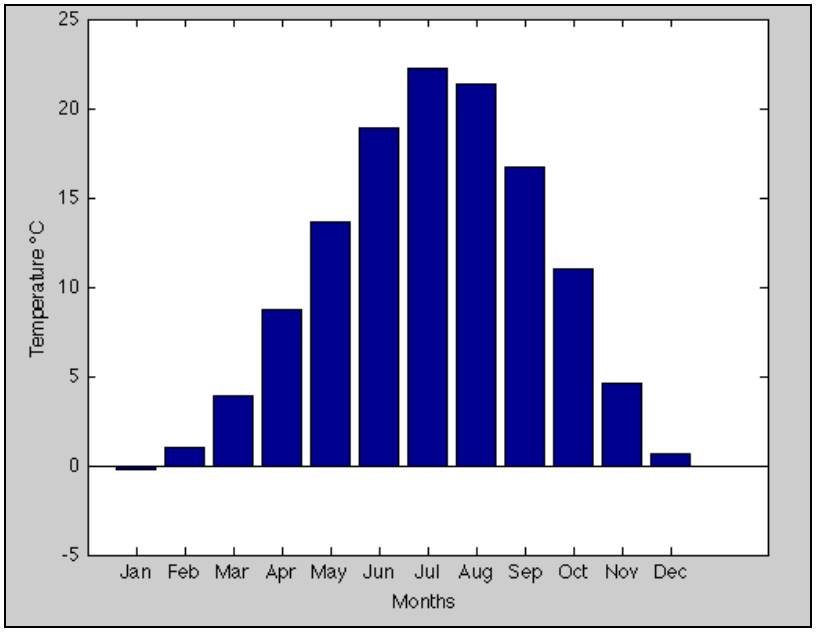
Precipitation (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Boulder, Co	16.8	19.7	43.3	64.0	79.5	52.5	40.7	38.3	37.8	31.7	28.7	16.6
Seattle, WA	124.5	98.8	86.5	56.0	45.3	34.4	15.4	25.9	47.7	82.8	111.2	146.6
Death Valley, CA	6.8	8	5.9	3.3	1.8	0.7	3.1	3.3	3.1	2.4	5	4.6
Dhaka, Bangladesh	8	20.7	58.4	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

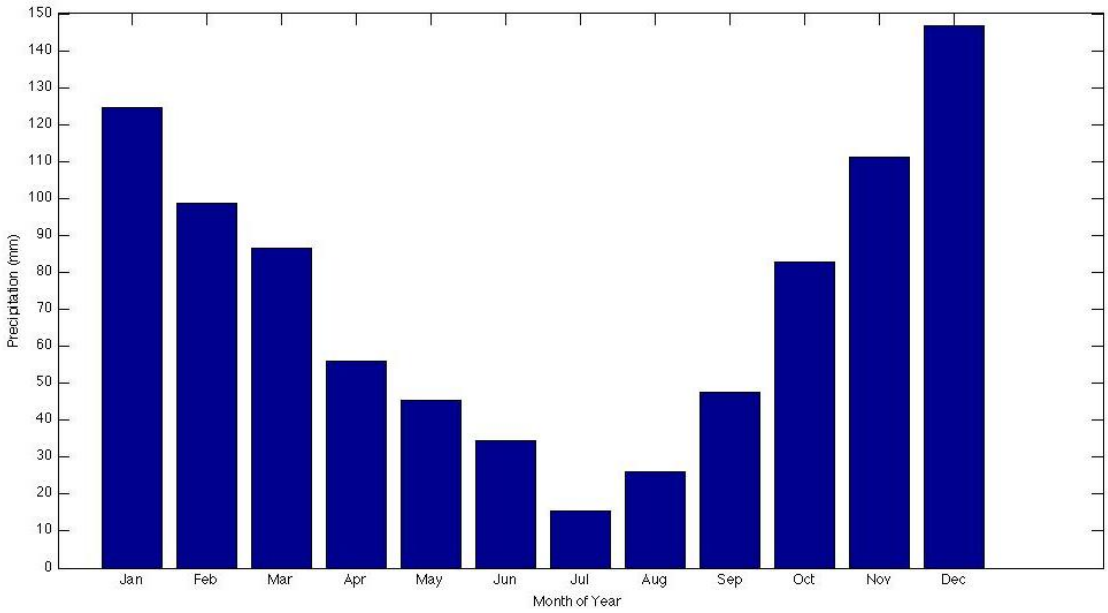
Bar Charts

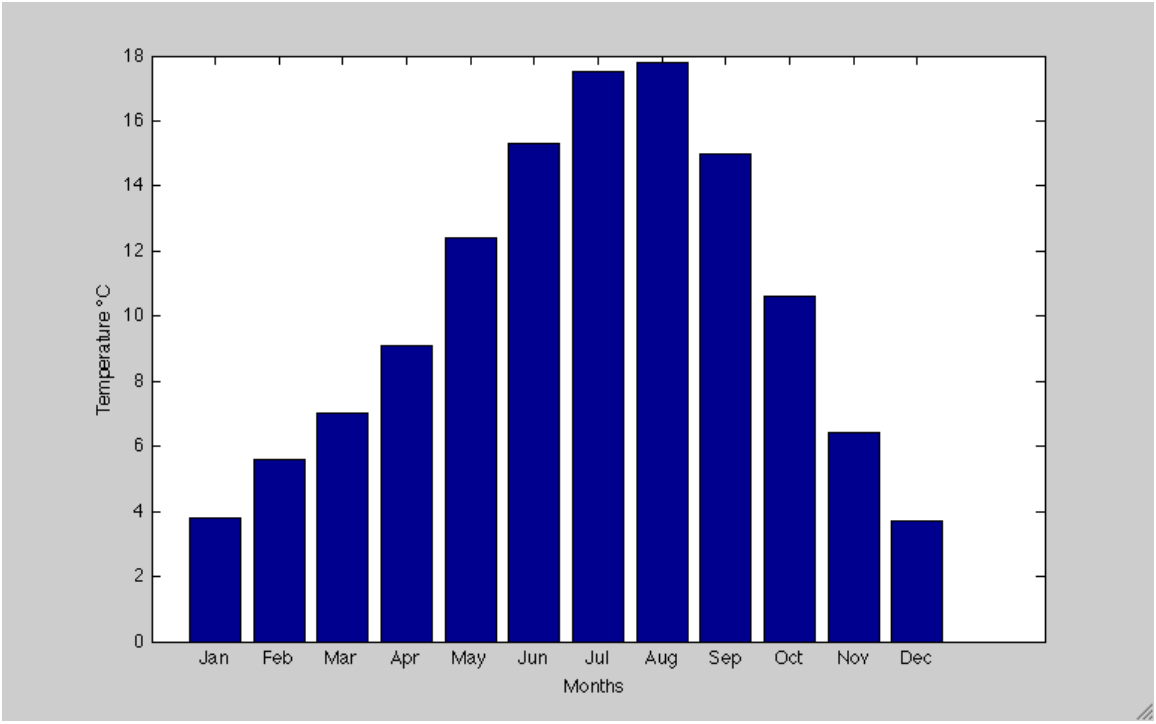
Boulder, CO
Total Annual Precipitation = 469.6mm



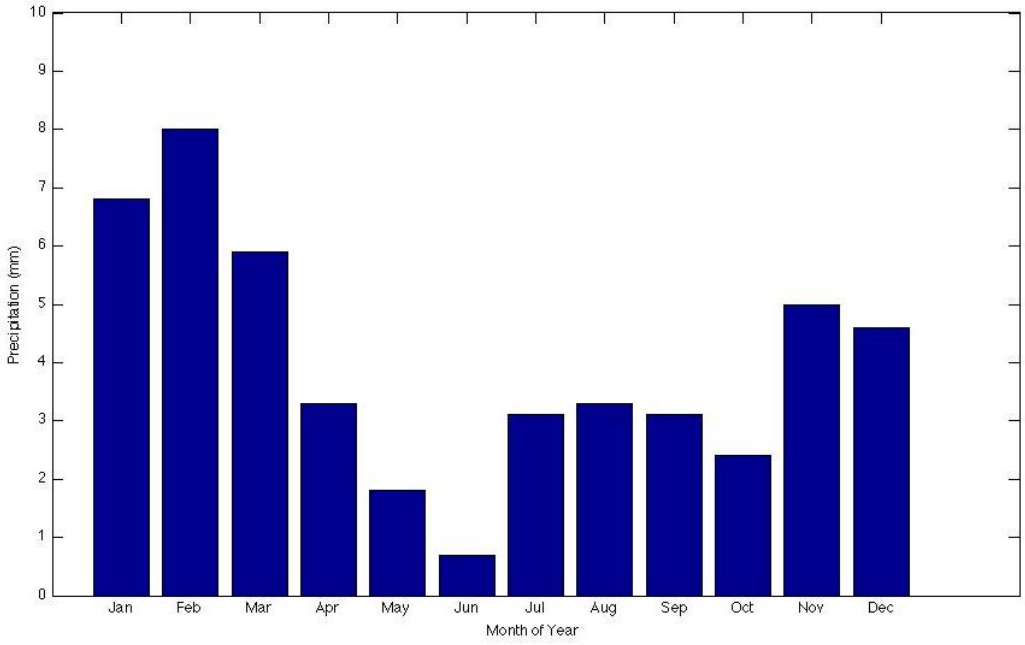


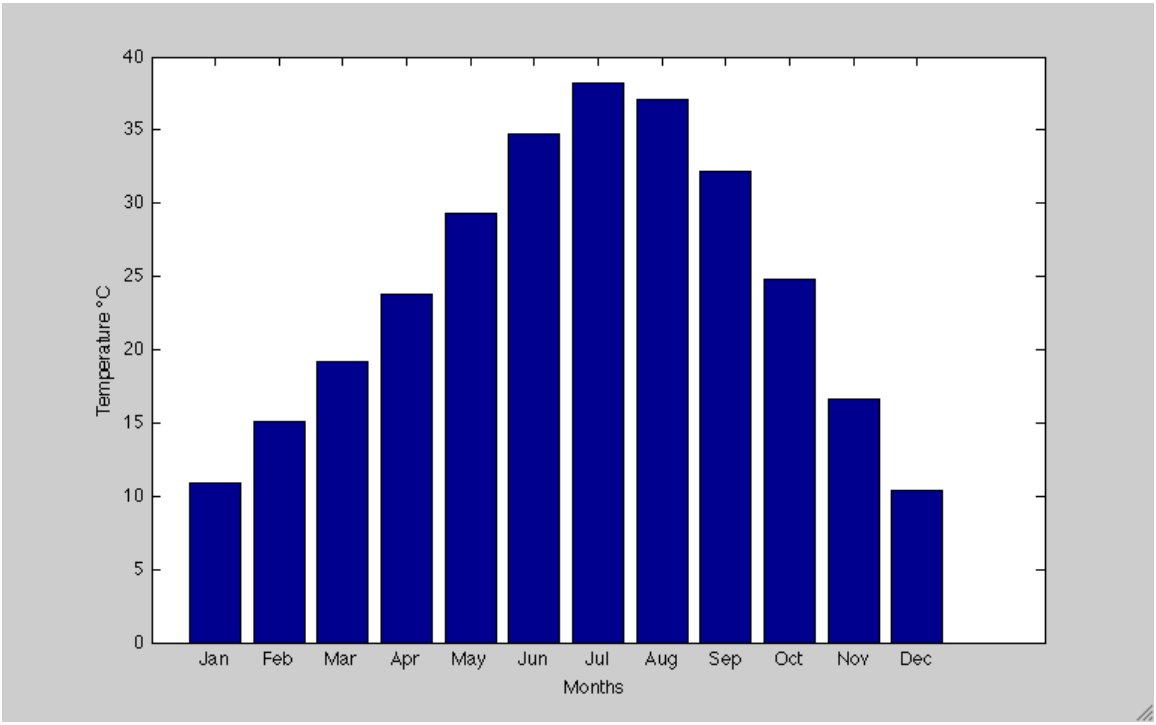
Seattle, WA
Total Annual Precipitation = 875.1 mm



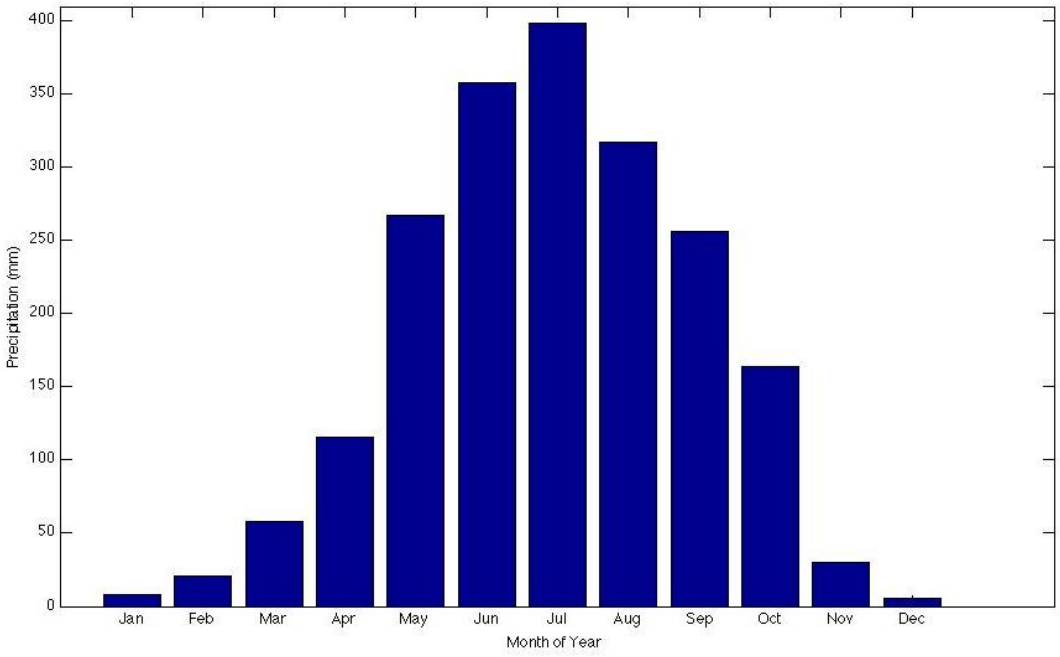


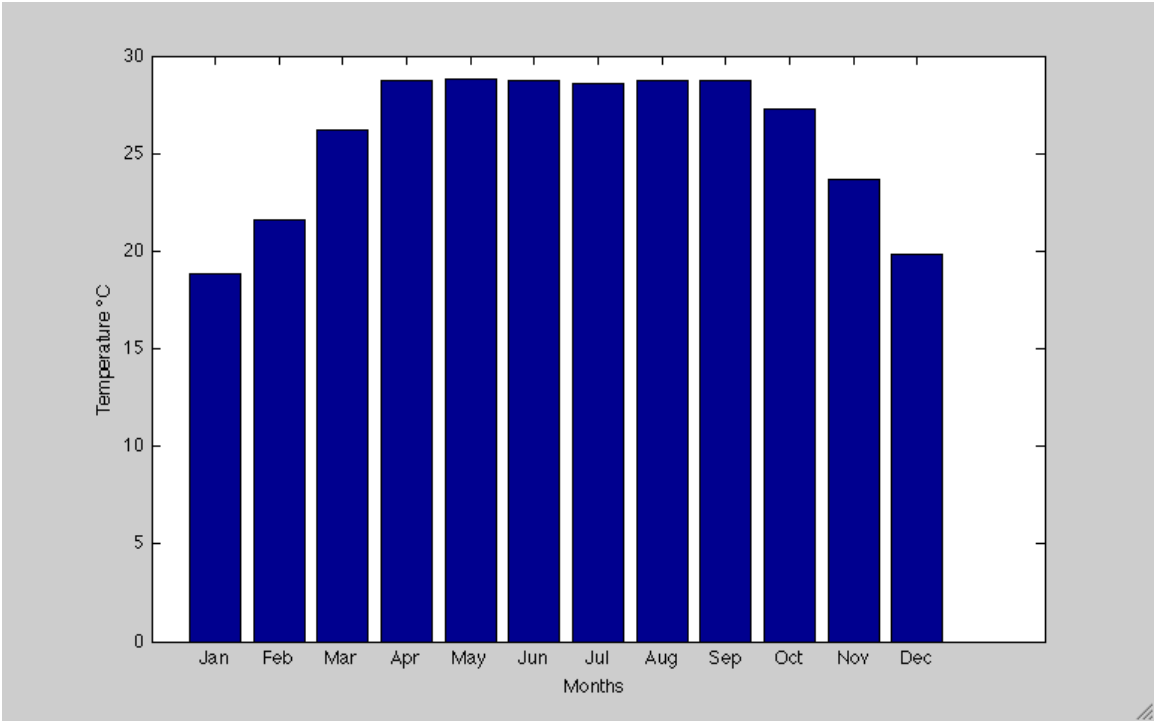
Death Valley, CA
Total Annual Precipitation = 48mm



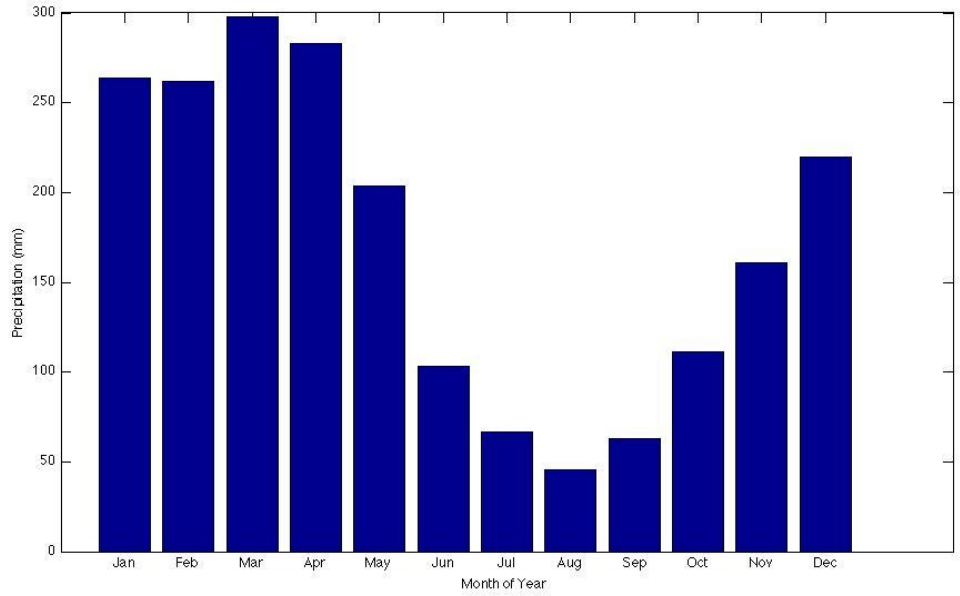


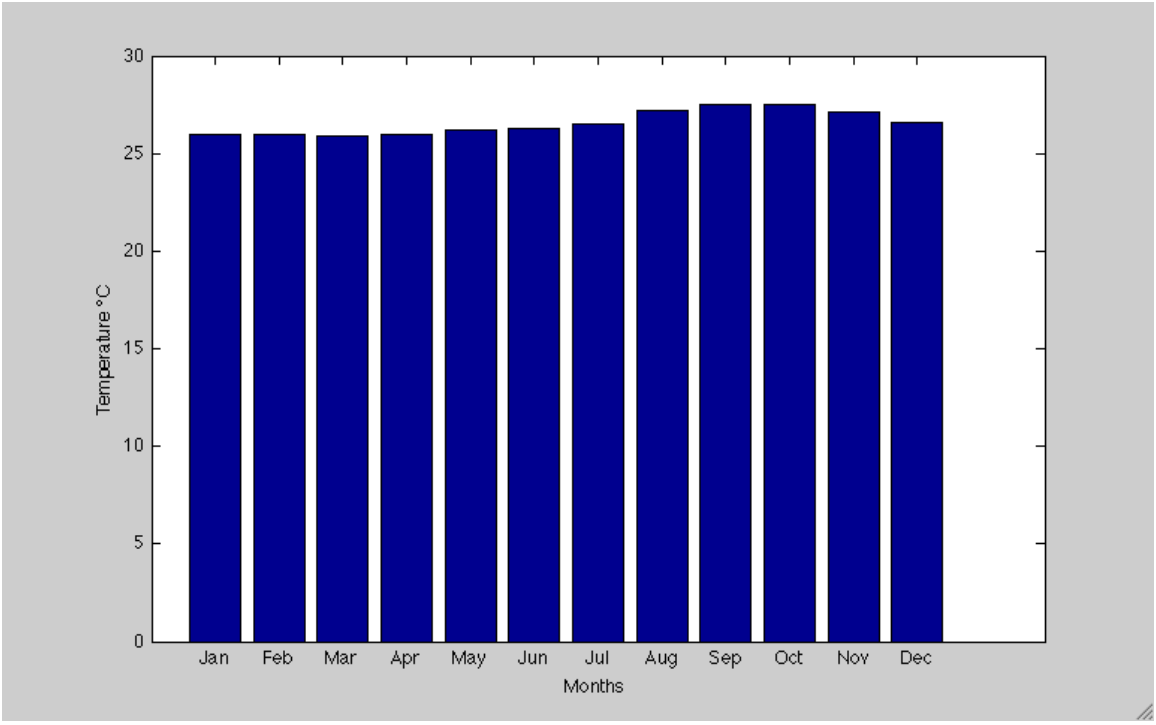
Dhaka, Bangladesh
Total Annual Precipitation = 1999.2mm



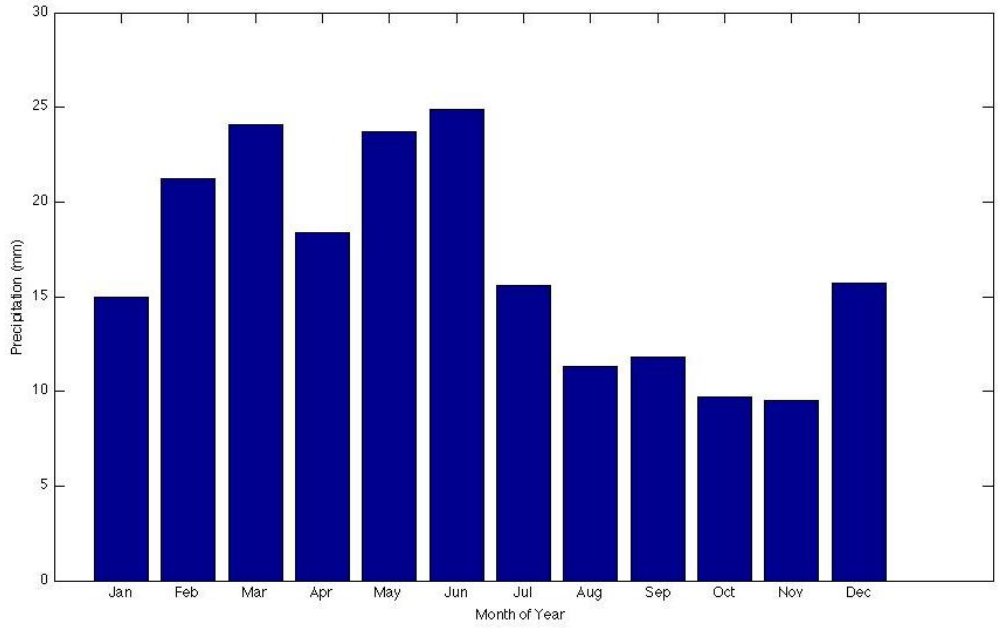


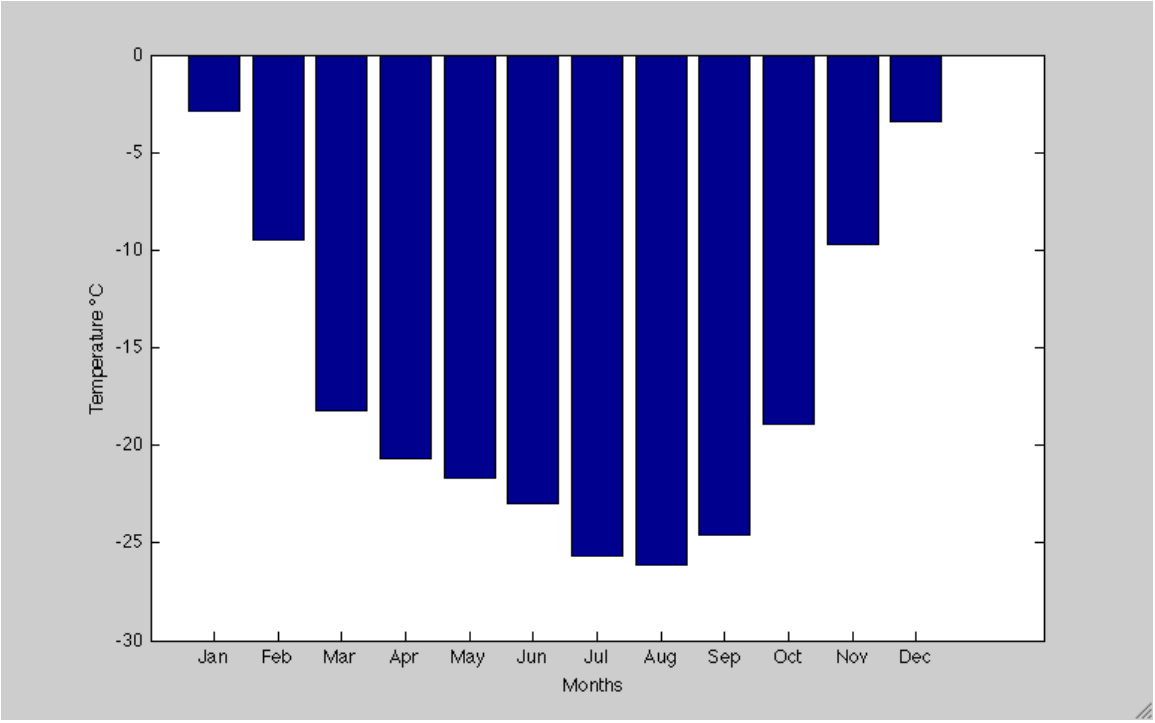
Manaus, Brazil
Total Annual Precipitation = 2080.7





McMurdo Station, Antarctica
Total Annual Precipitation = 200.9mm





WORLD MAP