Precipitation Towers: Teacher Guide

Lesson Overview:

This lesson uses cubes as a way to graph precipitation data to compare the precipitation averages and seasonal patterns for several different locations. There are several variations to accommodate various ages and ability levels.

Next Generation Science Standards: (www.nextgenscience.org)

The lesson relates to the following standards:

- K-ESS2-1. Use and share observations of local weather conditions to describe patterns over time.
- 3-ESS2-1. Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. [Clarification Statement: Examples of data could include average temperature, precipitation, and wind direction.]
- 3-ESS2-2. Obtain and combine information to describe climates in different regions of the world.
- 5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. [Clarification Statement: Examples could include the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.]
- MS-ESS2-6. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. [Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution]

Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data • Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (K-ESS2-1) • Represent data in tables and various graphical displays (bar graphs and pictographs) to reveal patterns that indicate relationships. (3-ESS2-1) **Developing and Using Models** • Develop and use a model to describe phenomena. (MS-ESS2-6)	**ESS2.D: Weather and Climate** • Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time. (K-ESS2-1) • Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next. (3-ESS2-1) • Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years. (3-ESS2-2) **ESS2.A: Earth Materials and Systems** • Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1)	**Patterns** • Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (K-ESS2-1) • Patterns of change can be used to make predictions. (3-ESS2-1),(3-ESS2-2) **Systems and System Models** • A system can be described in terms of its components and their interactions. (5-ESS2-1) • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. (MS-ESS2-6)

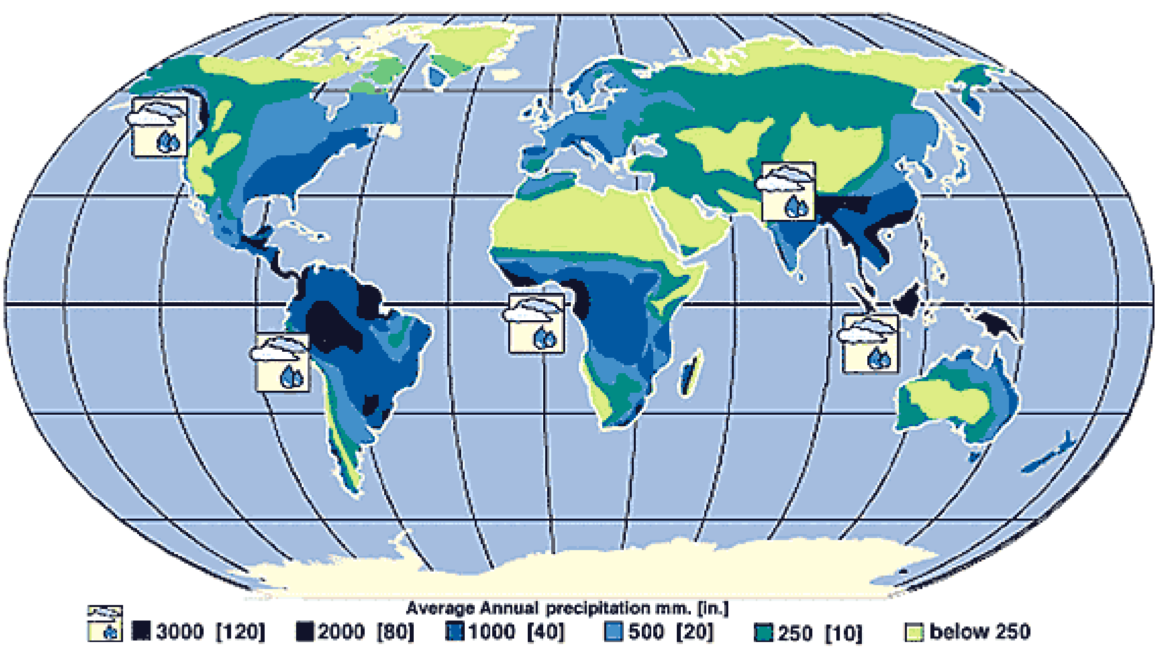
Common Core State Standards: (www.corestandards.org)

- **MP.4-** Model with mathematics. (K-ESS2-1) (3-ESS2-1),(3-ESS2-2),(5-ESS2-1)
- **MP.2 -** Reason abstractly and quantitatively. (K-ESS2-1) (3-ESS2-1),(3-ESS2-2),(5-ESS2-1)

Background Information:

Precipitation does not fall in the same amounts throughout the world, in a country, or even in a city. Some places get rain fairly evenly all during the year, while others may have strong seasonal patterns. The variation can be over a short distance as well. Summer thunderstorms may deliver an inch or more of rain on one suburb while leaving another area dry a few miles away. The world's record for average-annual rainfall belongs to Mt. Waialeale, Hawaii, where it averages about 450 inches (1,140 cm) per year. A remarkable 642 inches (1,630 cm) was reported there during one twelve-month period (that's almost 2 inches (5 cm) every day!). Is this the world record for the most rain in a year? No, that was recorded at Cherrapunji, India, where it rained 905 inches (2,300 cm) in 1861. Contrast those excessive precipitation amounts to Arica, Chile, where no rain fell for 14 years, and in Bagdad, California, where precipitation was absent for 767 consecutive days from October 1912 to November 1914.

The map below shows average annual precipitation, in millimeters and inches, for the world. The light green areas can be considered "deserts". You might expect the Sahara area in Africa to be a desert, but did you think that much of Greenland and Antarctica are deserts?



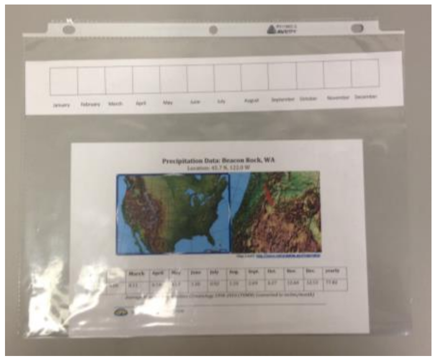
Credit: Earth Forum, Houston Museum of Natural Science

On average, the 48 continental United States receives enough precipitation in one year to cover the land to a depth of 30 inches (0.76 meters).

Adapted from: http://water.usgs.gov/edu/watercycleprecipitation.html

Materials:

- Cubes (such as Unifix, LEGO or any other stacking cube)
- Templates for the cities you with to use (from this teacher guide or created using the instructions in the Teacher Notes section and on page 31). An easy way to set up the templates is using a clear plastic sheet protector, as below:

  You can place the basic and advanced versions for each location back to back in one plastic sleeve to easily switch back and forth.
- Optional: projector and screen to show precipitation data visualizations and videos
- Optional: computers for students to gather their own data

Engage:

Use the accompanying presentation to introduce the lesson. First, ask students what precipitation is [slide 2] and ensure the major forms of precipitation (rain, snow, sleet, hail) are named. Next, have students think about what they know about precipitation and why different places on Earth get different amounts and types. This is to activate their background knowledge about the topic of the lesson: variations in precipitation in different locations.

Explore:

Have students work individually or in pairs or groups to build precipitation towers using the templates later in this teacher guide [slide 3]. You can hand out the included instructions pages, or use the instructions in the presentation [slides 4-5 for basic, slides 6-8 for intermediate]. The main difference between the two versions is that the basic data tables are already rounded to whole number, while the intermediate level requires rounding. In addition, the intermediate questions ask for more detailed observations and calculations such as range.

Questions with the basic version: (also found on the directions page)

- For one location only:
  - Which towers are the tallest? Which are the shortest?
  - What does the overall pattern look like? Are the towers all about the same height? Or is there a time of year that is clearly very rainy or very dry compared to the rest of the year?
- Compare two different locations:
  - Do they look the same or different? Describe how.
  - Stack up the blocks from both locations to get a total. Which location gets more rain for the whole year?

Questions to go with the intermediate version:

- For one location only:
  - Which months had the most precipitation? Which had the least?
  - What patterns do you see? Is there about the same amount of precipitation in all months, or are there times of the year that are noticeably wetter or drier?
  - How much difference is there between the wettest and driest month? Calculate the range of the data.
- Compare two different locations:
  - Is the pattern of the data the same or different? What about the ranges of the data? The total precipitation?
- Extension:
  - Move the blocks around to make the towers as even as possible (a physical way to find an average/mean). What do you think the average per month is?
  - Now calculate the average mathematically (divide the total precipitation for the year by 12 months). Is this different from what you got by the physical method? Why or why not?

Explain:

Discuss the results as a class or have student discuss as groups, and take the opportunity to point out interesting observations students have made. Some discussion points to consider: [slide 9]

IMPORTANT NOTE: The data used is from satellite observations, so it may not exactly match other ground sources of data. Satellites, especially the Tropical Rainfall Measuring Mission which was used for climatology averages because of its long data record, can tend to underreport precipitation, and has a harder time measuring snow. Because all the data came from the same source, comparisons between locations should be accurate, but if you use other sources of data for new locations, keep those differences in mind.

- Which location graphed seems to have the most precipitation? The least?
  - This will vary depending on the locations you choose, but should be easy for students to pick out. If not, you can have them refer to the total yearly precipitation number in the data tables.
- Which locations have similar precipitation patterns? Which are very different?
  - You can pull out specific months and have students hold up their cube stacks to do a comparison – a place that is overall very wet may still be drier in some months that a place that overall gets less precipitation, and the reverse.
  - Point out locations that have very even amounts of precipitation throughout the year, not more than a cube or two variation between any two months. The fact that the months may not all be exactly the same will confuse some students – they need to see that the overall pattern shows consistency throughout the year, even if not all stacks are precisely even.
  - Depending on the level of your students, this can also be a place to have them compare geographic features from the maps on the templates to find patterns between that and precipitation.
- What additional data would you need to be able to know if these towers represent rain or snow?
  - Temperature. Many weather websites have historical temperature averages if you want students to actually find this information for their locations.
- What other data might be useful for analyzing the weather?
  - Wind, humidity, barometric pressure, etc.
- What can some of the impacts of having too much or too little rainfall, either for the entire year or in different seasons?
  - Drought, flooding, agricultural impacts such as need for irrigation or not, etc.

- What differences in plants or animals might you expect to find in the different locations because of the precipitation amounts?
  - Comments will vary, but students may bring up deserts compared to grasslands, forests, rainforests, etc. and the different types of animals that live in those biomes. You could also bring in latitude/temperature differences as well and how those have an impact.
- What types of different activities do you expect humans to be able to do in the different locations because of the climate?
  - Skiing requires cold and snow, farming requires either enough rain or irrigation, outdoor swimming and other water sports may occur more often in wet areas, etc.

Evaluate:

The data and observations recorded on the student capture sheet could be used as an assessment. In addition, you could have student create a more traditional graph of the data on paper and use that as an assessment.

Elaborate/Extend:

- Show students the animation of the first global map of rainfall and snowfall produced by the Global Precipitation Measurement Mission, http://svs.gsfc.nasa.gov/goto?4257 or https://youtu.be/o3OhA_f3-Ig and ask them to look for interesting patterns. [slide 10] Some patterns to point out if they don't see them:
  - Storms in the higher latitudes (both north and south) move west to east, while storms near the equator move east to west.
  - Areas of snow in the blue/purple scale, as well as rain in the red/yellow/green scale.
  - Large frontal storms in the higher latitudes and smaller, shorter lived storms near the equator.
  - Rotation of storms, and a discussion of hurricanes- some are visible near Japan and in the Pacific approaching Hawaii in early August 2014 (zoomed in versions http://svs.gsfc.nasa.gov/goto?4295 and http://svs.gsfc.nasa.gov/goto?4292)
  - Narrated videos discussing this dataset are available here: http://svs.gsfc.nasa.gov/goto?11784 and here: http://svs.gsfc.nasa.gov/goto?11829.
  - The most recent week of data can be viewed here: http://svs.gsfc.nasa.gov/goto?4285
- Here are a few videos that discuss the implications of how much precipitation an area gets:
  - "Too Much, Too Little" (4:44): Researchers need accurate and timely rainfall information to better understand and model where and when severe floods, frequent landslides and devastating droughts may occur. GPM's global rainfall data will help to better prepare and respond to a wide range of natural disasters. - http://go.nasa.gov/KEUfUV or https://youtu.be/6cU5Rt0rcGA
  - "Accessing Drought in the United States" (6:05): This animation from the Community Collaborative Rain Hail and Snow Network shows how decision makers use a variety of data and in-person reports to assess the drought conditions across the United States. http://go.nasa.gov/1NiEyLO or https://youtu.be/i7F6QwRqyVI
  - "Science for A Hungry World: Growing Water Problems" (4:53): One of the biggest changes to global agriculture is less about the food itself as it is about the water we use to grow it. In some areas, farmers are using freshwater resources - including groundwater - at an alarming rate. http://go.nasa.gov/1iBTyHy or https://youtu.be/1RJ6AqWAOEg.

Teacher Notes:

If you expect to use the activity with varying grade levels, or allow students to choose between the basic and intermediate sides, you can put both versions for the same location back to back in a plastic sheet protector, making it easy to go back and forth between the two. While this lesson is written as a whole-class activity, it would also make an excellent learning center, or an activity as part of a family science or math night.

Directions are given at the end of this guide to access one source of long-term precipitation averages, if you wish to create a graphing template for your own choice of locations. While including a map of the location and general surrounding geography is not required, it is helpful if you wish to have students think about reasons for the different amounts of precipitations. The maps in this guide were created using the National Map Viewer (http://viewer.nationalmap.gov/viewer/) with annotations added using Microsoft Word. Unfortunately, the Map Viewer is only supported as a legacy product at this point, and the particular elevation color shaded relief map is no longer easily accessible on the web service. If you have familiarity with GIS software and GeoTIFFs, the dataset (which only includes the United States) can still be downloaded here: https://www.sciencebase.gov/catalog/item/535fe573e4b078dca33ae65c.

Other options for creating maps are Google Maps using the “terrain” overlay (http://maps.google.com) or the National Geographic MapMaker Interactive (http://mapmaker.education.nationalgeographic.com/) which has both a “topo” and a “terrain” base map that could be used. There is also a “Surface Elevation” layer which can be added (“Add Layer” and look under “Earth Systems” – adjust the transparency to be able to read the labels), but the color scheme is not as nice as the National Map Viewer’s shaded relief.

Additional Resources:

For more advanced or older students, the Geographical Influences on Climate Lesson, produced by GPM, has instructions for more detailed comparisons as well as adding temperature data into the mix. There are ready-made graphs of different U.S. locations, as well as instructions for students to collect data and create their own climatogram. http://go.nasa.gov/1hzTLic

Resources in the rest of this guide:

Page 7: Table with data summary for the eleven location templates included in this guide

Pages8 - 19: Directions sheet and templates for the basic version (rounding already done)

Pages 20-31: Directions sheet and templates for the advanced version (requires rounding)

➔ Both versions have graphing templates for the following locations:

Astoria, Oregon	New York, New York
Beacon Rock, Washington	Pendleton, Oregon
Baltimore, Maryland	San Francisco, California
El Paso, Texas	Vail, Colorado
Greenbelt, Maryland	Washington, D.C.
Little Rock, Arkansas	

Page 32: Directions to get average climatology data from the Tropical Rainfall Measuring Mission’s long-term records, using MY NASA DATA. Note that there are other places to get historical averages, this is merely one source.

Summary of precipitation data for the city templates included in this guide:

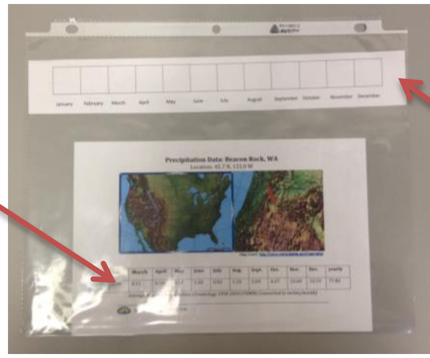
City	State	Latitude	Longitude	Total Precipitation (inches)	Mean Precipitation (inches/month)	Month of max precipitation	Month of min precipitation	Range of Precip (inches)	Pattern Notes
Astoria	OR	46.2	-123.8	67.51	5.63	Nov	Jul	10.12	Drier mid-year Jun-Sep, wettest Nov-Jan, high seasonal variation
Baltimore	MD	39.3	-76.7	39.97	3.33	Sep	Feb	1.50	Fairly consistent all year, not much variation seasonally
Beacon Rock	WA	45.7	-122.0	77.82	6.49	Nov	Jul	11.72	Drier mid-year Jun-Sep, wettest Nov-Jan, high seasonal variation
El Paso	TX	31.8	-106.5	8.06	0.67	Jul	Mar/Apr	1.43	Dry all year, but slightly less dry Jul-Sep
Greenbelt	MD	39.0	-76.9	39.85	3.32	Jun	Nov	1.49	Fairly consistent all year, not much variation seasonally
Little Rock	AR	34.7	-92.3	46.44	3.87	Dec	Aug	2.80	Fairly consistent all year, not much variation seasonally
New York	NY	40.7	-74.0	43.07	3.59	Jun	Feb	1.50	Fairly consistent all year, not much variation seasonally
Pendleton	OR	4.7	-118.8	14.24	1.19	Dec	Jul	1.72	Dry all year, driest period Jul-Sep
San Francisco	CA	39.2	-119.8	23.80	1.98	Dec	Jul	4.56	Very dry May-Oct compared to Nov-Apr, high seasonal variation
Vail*	CO	39.5	-106.4	15.89	1.32	May	Dec	1.48	Somewhat wetter Apr-Oct compared to Nov-Mar; keep in mind that much winter precipitation would be snow, and one inch of snow has less water than one inch of rain
Washington	DC	38.9	-77.0	37.74	3.15	Jun	Feb	1.38	Fairly consistent all year, not much variation seasonally

**NOTE: Because Vail is in an area that gets much of its precipitation in the form of snow, and the satellite tends to underreport snow, these numbers may be lower than those you would find from other data sources, but are from the same data set as all the other locations included for consistency.*

Looking at Data: Building Precipitation Towers

Basic Directions

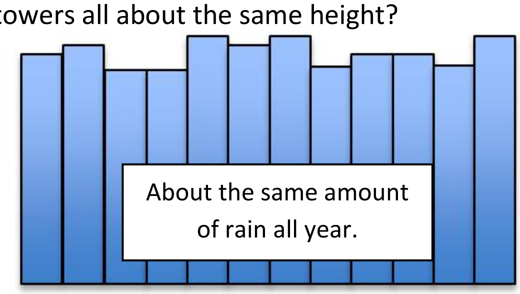
Look at the data table.



Count out the number of cubes for each month, and place them on the matching square.

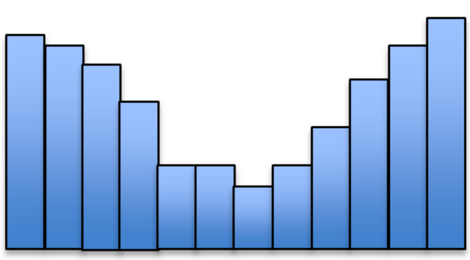
After you have placed all the cubes, look for patterns in the data.

- Which towers are the tallest? Which are the shortest?
- What does the overall pattern look like?
  - Are the towers all about the same height?

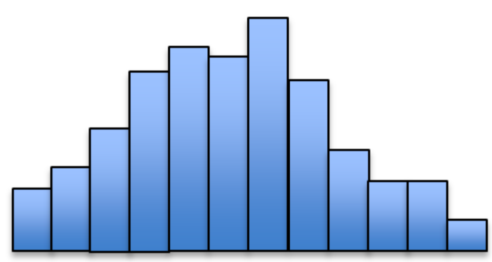


  - Or is there a time of year that is clearly very rainy or very dry compared to the rest of the year?

Drier during middle of the year, wetter during the beginning and end



Wetter during the middle of the year, drier at the beginning and end.



January	February	March	April	May	June	July	August	September	October	November	December

Precipitation Data (Basic): Astoria, OR

Location: 46.2 N, 123.8 W

Map credit: http://www.nationalatlas.gov/mapmaker

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
10	7	7	5	3	3	1	1	2	6	11	10	66

Average Monthly Precipitation Climatology 1998-2010 (TRMM) (converted to inches/month and rounded to whole numbers)

January February March April May June July August September October November December

Precipitation Data (Basic): Baltimore, MD

Location: 39.3 N, 76.6 W

Map credit: http://www.nationalatlas.gov/mapmaker

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
3	3	3	3	3	4	4	3	4	3	3	3	39

Average Monthly Precipitation Climatology 1998-2010 (TRMM) (converted to inches/month and rounded to whole numbers)

January	February	March	April	May	June	July	August	September	October	November	December

Precipitation Data (Basic): Beacon Rock, WA

Location: 45.7 N, 122.0 W

Map credit: http://www.nationalatlas.gov/mapmaker

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
11	9	8	6	4	3	1	1	3	6	13	13	78

Average Monthly Precipitation Climatology 1998-2010 (TRMM) (converted to inches/month and rounded to whole numbers)

January	February	March	April	May	June	July	August	September	October	November	December

Precipitation Data (Basic): El Paso, TX

Location: 31.8 N, 106.5 W

Map credit: http://www.nationalatlas.gov/mapmaker

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
0	1	0	0	0	1	2	2	1	1	1	0	9

Average Monthly Precipitation Climatology 1998-2010 (TRMM) (converted to inches/month and rounded to whole numbers)

January	February	March	April	May	June	July	August	September	October	November	December

Precipitation Data (Basic): Greenbelt, MD

Location: 39.0 N, 76.9 W

Map credit: http://www.nationalatlas.gov/mapmaker

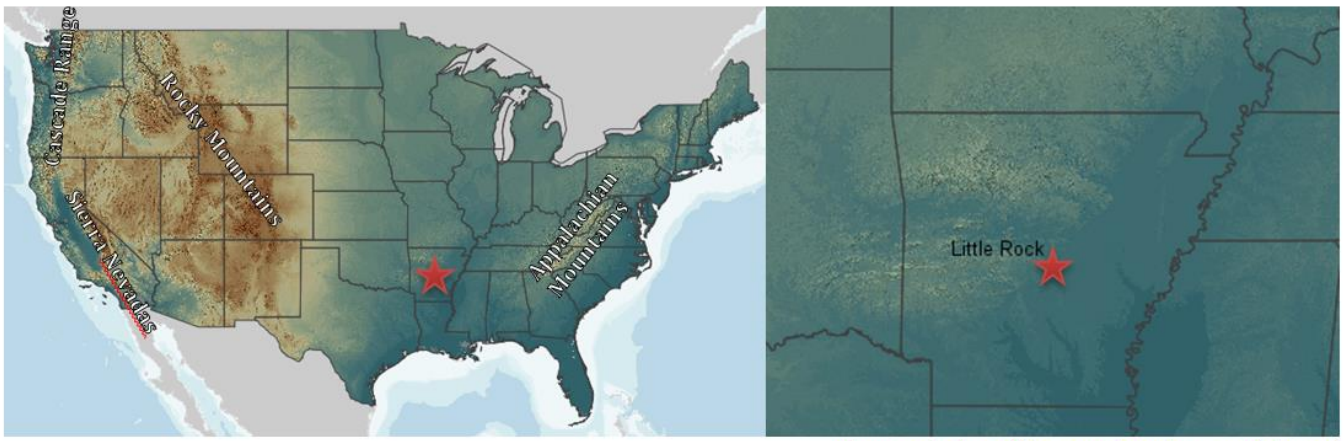
Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
3	3	3	3	4	4	4	3	4	3	3	3	40

Average Monthly Precipitation Climatology 1998-2010 (TRMM) (converted to inches/month and rounded to whole numbers)

January	February	March	April	May	June	July	August	September	October	November	December

Precipitation Data (Basic): Little Rock, AR

Location: 34.7 N, 92.3 W



Map credit: http://viewer.nationalmap.gov/viewer/

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
3	4	5	4	5	3	3	2	3	5	4	5	46

Average Monthly Precipitation Climatology 1998-2010 (TRMM) (converted to inches/month)

January	February	March	April	May	June	July	August	September	October	November	December

Precipitation Data (Basic): New York, NY

Location: 40.7 N, 74.0 W

Map credit: http://viewer.nationalmap.gov/viewer/

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
4	3	4	4	3	4	4	4	4	3	3	4	43

Average Monthly Precipitation Climatology 1998-2010 (TRMM) (converted to inches/month and rounded to whole numbers)

January February March April May June July August September October November December

Precipitation Data (Basic): Pendleton, OR

Location: 45.7 N, 118.8 W

Map credit: http://www.nationalatlas.gov/mapmaker

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
2	1	1	1	1	1	0	1	1	1	2	2	14

Average Monthly Precipitation Climatology 1998-2010 (TRMM) (converted to inches/month and rounded to whole numbers)

January	February	March	April	May	June	July	August	September	October	November	December

Precipitation Data (Basic): San Francisco, CA

Location: 39.2 N, 119.8 W

Map credit: http://www.nationalatlas.gov/mapmaker

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
5	5	3	1	1	0	0	0	0	1	3	5	24

Average Monthly Precipitation Climatology 1998-2010 (TRMM) (converted to inches/month and rounded to whole numbers)

January	February	March	April	May	June	July	August	September	October	November	December

Precipitation Data (Intermediate): Vail, CO

Location: 39.5 N, 106.4 W

Map credit: http://www.nationalatlas.gov/mapmaker

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
0.71	0.75	1.10	1.85	2.15	1.46	1.61	1.70	1.42	1.63	0.84	0.67	15.89

Average Monthly Precipitation Climatology 1998-2010 (TRMM) (converted to inches/month)

NOTE: Because this is in an area that gets much of its precipitation in the form of snow, and the satellite tends to underreport snow, these numbers may be lower than those you would find from other data sources, but are from the same data set as all the other locations included.

January February March April May June July August September October November December

Precipitation Data (Basic): Washington, D.C.

Location: 38.9 N, 77.0 W

Map credit: http://www.nationalatlas.gov/mapmaker

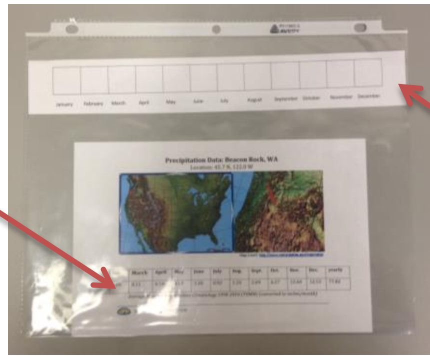
Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
3	3	3	3	3	4	3	3	4	3	3	3	38

Average Monthly Precipitation Climatology 1998-2010 (TRMM) (converted to inches/month and rounded to whole numbers)

Looking at Data: Building Precipitation Towers

Intermediate Directions

Look at the map and data table.



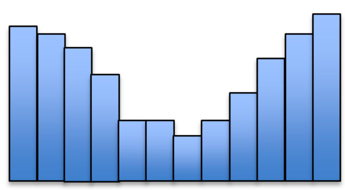
Place the appropriate number of cubes on the matching square.

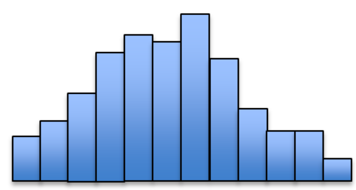
You will need to round to a whole number – remember your decimal rounding rules:

- #.00 to #.49 → round down
- #.50 to #.99 → round up

After you have placed all the cubes, look for trends in the data.

- Which months had the most precipitation? Which had the least?
- What patterns do you see? Is there about the same amount of precipitation in all months, or are there times of the year that are noticeably wetter or drier?





- How much difference is there between the wettest and driest month? Calculate the range of the data.
- Build the precipitation towers for another location (or look at another group's completed towers) and compare them to the first one. Is the pattern of the data the same or different? What about the ranges of the data? The total precipitation?

Bonus: Move the blocks around to make the towers as even as possible (a physical way to find an average/mean). What do you think the average per month is? Now calculate the average mathematically (divide the total precipitation for the year by 12 months). Is this different from what you got by the physical method? Why or why not?

January	February	March	April	May	June	July	August	September	October	November	December

Precipitation Data (Intermediate): Astoria, OR

Location: 46.2 N, 123.8 W

Map credit: http://www.nationalatlas.gov/mapmaker

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
10.20	7.44	7.45	5.20	3.32	2.55	1.03	1.16	2.14	5.98	11.15	9.89	67.51

Average Monthly Precipitation Climatology 1998-2010 (TRMM) (converted to inches/month)

January	February	March	April	May	June	July	August	September	October	November	December

Precipitation Data (Intermediate): Baltimore, MD

Location: 39.3 N, 76.6 W

Map credit: http://www.nationalatlas.gov/mapmaker

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
3.28	2.79	3.36	3.39	3.42	4.10	3.56	3.03	4.29	3.00	2.60	3.15	39.97

Average Monthly Precipitation Climatology 1998-2010 (TRMM) (converted to inches/month)

January	February	March	April	May	June	July	August	September	October	November	December

Precipitation Data (Intermediate): Beacon Rock, WA

Location: 45.7 N, 122.0 W

Map credit: http://www.nationalatlas.gov/mapmaker

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
10.96	9.09	8.11	6.14	4.07	3.30	0.92	1.10	2.69	6.27	12.64	12.53	77.82

Average Monthly Precipitation Climatology 1998-2010 (TRMM) (converted to inches/month)

January	February	March	April	May	June	July	August	September	October	November	December

Precipitation Data (Intermediate): El Paso, TX

Location: 31.8 N, 106.5 W

Map credit: http://www.nationalatlas.gov/mapmaker

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
0.18	0.51	0.20	0.20	0.28	0.73	1.63	1.56	1.13	0.85	0.50	0.29	8.06

Average Monthly Precipitation Climatology 1998-2010 (TRMM) (converted to inches/month)

January	February	March	April	May	June	July	August	September	October	November	December

Precipitation Data (Intermediate): Greenbelt, MD

Location: 39.0 N, 76.9 W

Map credit: http://www.nationalatlas.gov/mapmaker

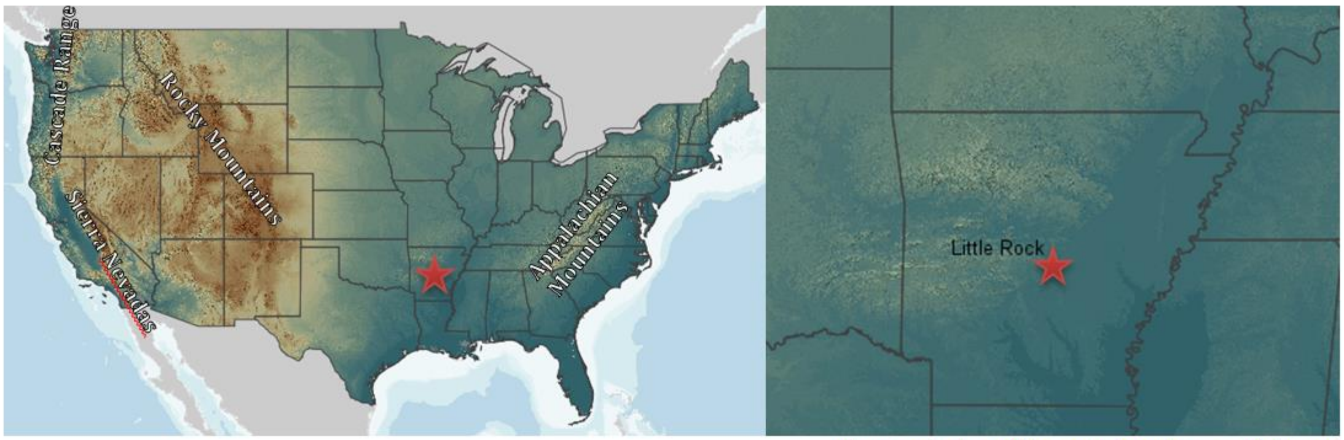
Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
3.33	2.65	3.32	3.22	3.55	4.30	3.58	3.25	3.71	3.01	2.81	3.12	39.85

Average Monthly Precipitation Climatology 1998-2010 (TRMM) (converted to inches/month)

January February March April May June July August September October November December

Precipitation Data (Intermediate): Little Rock, AR

Location: 34.7 N, 92.3 W



Map credit: http://viewer.nationalmap.gov/viewer/

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
3.46	3.55	4.57	3.90	4.85	3.29	3.37	2.27	3.36	4.72	4.03	5.07	46.45

Average Monthly Precipitation Climatology 1998-2010 (TRMM) (converted to inches/month)

January February March April May June July August September October November December

Precipitation Data (Intermediate): New York, NY

Location: 40.7 N, 74.0 W

Map credit: http://viewer.nationalmap.gov/viewer/

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
3.57	2.80	3.60	3.77	3.49	4.30	3.50	3.61	4.15	3.43	2.99	3.86	43.07

Average Monthly Precipitation Climatology 1998-2010 (TRMM) (converted to inches/month)

January	February	March	April	May	June	July	August	September	October	November	December

Precipitation Data (Intermediate): Pendleton, OR

Location: 45.7 N, 118.8 W

Map credit: http://www.nationalatlas.gov/mapmaker

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1.85	1.18	1.40	1.17	1.34	1.05	0.28	0.53	0.64	1.15	1.65	2.00	14.24

Average Monthly Precipitation Climatology 1998-2010 (TRMM) (converted to inches/month)

January February March April May June July August September October November December

Precipitation Data (Intermediate): San Francisco, CA

Location: 39.2 N, 119.8 W

Map credit: http://www.nationalatlas.gov/mapmaker

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
4.50	4.61	3.26	1.46	0.70	0.16	0.00	0.06	0.21	1.12	3.16	4.56	23.80

Average Monthly Precipitation Climatology 1998-2010 (TRMM) (converted to inches/month)

January February March April May June July August September October November December

Precipitation Data (Basic): Vail, CO

Location: 39.5 N, 106.4 W

Map credit: http://www.nationalatlas.gov/mapmaker

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1	1	1	2	2	1	2	2	1	2	1	1	17

Average Monthly Precipitation Climatology 1998-2010 (TRMM) (converted to inches/month and rounded to whole numbers)

NOTE: Because this is in an area that gets much of its precipitation in the form of snow, and the satellite tends to underreport snow, these numbers may be lower than those you would find from other data sources, but are from the same data set as all the other locations included for consistency.

January February March April May June July August September October November December

Precipitation Data (Intermediate): Washington, D.C.

Location: 38.9 N, 77.4 W

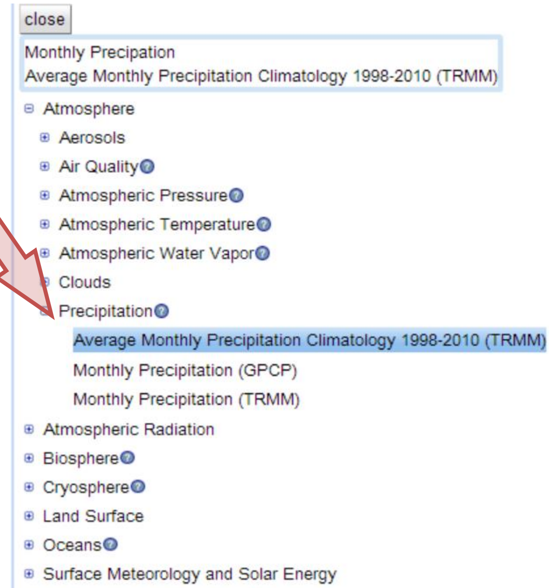
Map credit: http://www.nationalatlas.gov/mapmaker

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
3.22	2.68	3.09	3.18	3.42	4.06	3.25	3.14	3.67	2.62	2.70	2.71	37.75

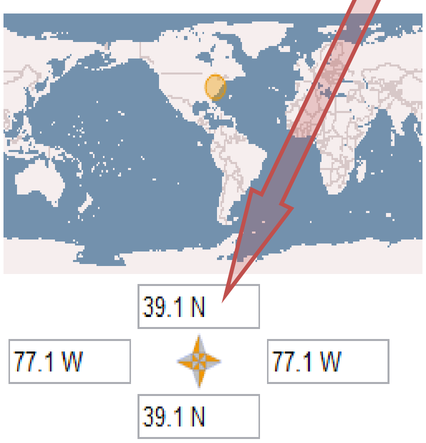
Average Monthly Precipitation Climatology 1998-2010 (TRMM) (converted to inches/month)

Directions to get TRMM precipitation data from MY NASA DATA:

1. Go to https://mynasadata.larc.nasa.gov/live-access-server/ and click on the link for the Live Access Server (Advanced Edition).
2. Choose *Atmosphere > Precipitation > Average Monthly Precipitation Climatology 1998-2010 (TRMM)*
   (If the window at right doesn't come up automatically, click the *Data Set* button in the upper left.)

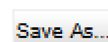


3. In the boxes by the compass, enter the latitude and longitude for your location. You should see a dot appear at your location on the map. Choose *Time* under *Line Plots*.



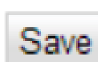
4. Click the *Update Plot* from the menu bar near the top.

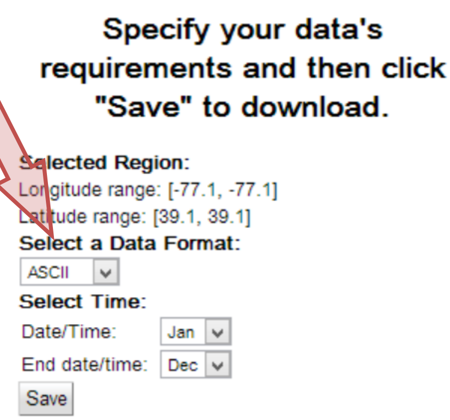
5. We want the data table, not a line plot, so you will need to save the data to use elsewhere. Chose *Save As* from the menu bar.



In the choices that appear, change the *Select a Data Format* option to be *ASCII.*

6. Click the *Save* button.





7. The data will come up in a new window. Chose *File > Save As* and save the document in a place you can find it, with a name that includes your location and "precipitation" or "precip."

8. You can use Excel or any other spreadsheet program to open your document (you will probably need to open the program and find where the file is saved, rather than just double-clicking). Note that the data downloaded is average mm/day for the month in question, so to get total precipitation for each month, you will need to multiply by the number of days in each month. Also note that if you wish to use inches, as for the rest of the examples in this guide, you will need to convert from mm as well. To convert mm to inches, multiply by 0.038.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
31	28	31	30	30	30	31	31	30	31	30	31