Geographical Influences on Climate Teacher Guide

Lesson Overview:
Students will compare the climatograms for different locations around the United States to observe patterns in temperature and precipitation. They will describe geographical features near those locations, and compare graphs to find patterns in the effect of mountains, oceans, elevation, latitude, etc. on temperature and precipitation. Then, students will research temperature and precipitation patterns at various locations around the world using the MY NASA DATA Live Access Server and other sources, and use the information to create their own climatogram.

Expected time to complete lesson: One 45 minute period to compare given climatograms, one to two 45 minute periods to research another location and create their own climatogram. To lessen the time needed, you can provide students data rather than having them find it themselves (to focus on graphing and analysis), or give them the template to create a climatogram (to focus on the analysis and description), or give them the assignment for homework. See *GPM Geographical Influences on Climate – Climatogram Template and Data* for these options.

Learning Objectives:
- Students will brainstorm geographic features, consider how they might affect temperature and precipitation, and discuss the difference between weather and climate.
- Students will examine data about a location and calculate averages to compare with other locations to determine the effect of geographic features on temperature and precipitation.
- Students will research the climate patterns of a location and create a climatogram and description of what factors affect the climate at that location.

National Standards:
ESS2.D: Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns.

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. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.] [Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect.*

From the Next Generation Science Standards, available at http://www.nextgenscience.org/

Background Information:
Many factors affect the climate of a location. The first important distinction to understand is the difference between weather and climate – weather is the short-term conditions of the atmosphere, such as temperature, precipitation, humidity, etc. Climate is the longer-term patterns in an area. For more information about the differences and how and why NASA studies climate, visit http://www.nasa.gov/mission_pages/noaa-n/climate/climate_weather.html

Latitude is a primary factor that has an influence on climate, due to the relationship between the Earth's tilt and the changing angle of incoming solar radiation at different times of the year. This lesson does not primarily discuss latitudinal differences. For a lesson that does, see http://education.nationalgeographic.com/education/activity/latitude-longitude-temperature/.

Some of the secondary factors that affect climate are nearness to large bodies of water, elevation, the rain shadow effect of mountains, global wind and ocean current patterns, cloud cover, and surface albedo. This lesson primarily addresses the first three. In general, we expect cities near water to have a more moderate temperature (a smaller range between day and night and between seasons) and more precipitation, although this is affected by whether the location is on the windward or leeward side of the water based on prevailing wind patterns. Average temperature decreases with elevation, and precipitation is strongly affected by the nearness of mountains. The windward side of a mountain range will have higher precipitation, and the leeward side will often be in a rain shadow, with drastically decreased precipitation.
For more information, visit these links:

- http://people.cas.sc.edu/carbone/modules/mods4car/ccontrol/index.html.
- http://www.nature.com/scitable/knowledge/library/introduction-to-the-basic-drivers-of-climate-13368032

Materials:

- Printouts of climatograms (preferably in color, may be laminated to use repeatedly)
- Access to computers for climate research, or printouts of data for teacher-chosen locations

Engage:
Using the *GPM Geographical Influences on Climate - Presentation*, discuss geographic features and how they might influence temperature and precipitation in a location *(slide 3 & 4)*. Depending on the level of your students, you may need to discuss what a geographic feature actually is (especially if you have many English Language Learners). Students may be tempted to say that man-made features count – roads, buildings, bridges, etc. You may wish to steer them toward natural features such as lakes, mountains, oceans, and so on, although the urban heat island effect could be discussed if you wish. (For more information on heat islands: www.epa.gov/hiri/.) The clip-art pictures (a lake, river valley/hills, mountains and the ocean/beach) will appear after the text, so you can use them as hints if your students are having trouble coming up with ideas, or as vocabulary development for English Language Learners. The chart to record geographic features and their possible effect on climate (*slide 4*), is intended to be completed on a smart board of some sort – it could also be filled out on a white board or chart paper.

As an additional engage activity, or as a more guided substitute for the brainstorming on *slide 3*, show them the image of an ash and steam plume from the Soufriere Hills volcano in Montserrat (*slide 5*). Students should notice that A appears to be somewhat elevated, while C is at sea level and right near the water. B is clearly being affected by the ash plume from the volcano, which may lead into a discussion of short-term versus long-term factors. (A will always be at a higher elevation, and C will always be near water, but B will not always have an ash plume over it.) A fuller discussion of weather versus climate will occur later.

One of the key concepts to understand our Earth system is the difference between weather and climate. Use the Venn diagram (*slide* 6) to compare and contrast the two. Ideally this should be done by filling out the diagram on a Smart Board. The primary difference here is the time scale - weather is looking at the short term; whether it will rain and what the temperature will be like for the next few days. Climate is looking at the long term; data averaged over a longer period of time. It can actually be easier to make models that predict climate over the long term, even though meteorologists can't always tell us accurately if it will rain tomorrow. Both weather and climate measure temperature, precipitation, humidity, wind speed and direction, etc., but over a different time frame.

Explore:

Introduce the idea of a climatogram (a double graph that shows both temperature and precipitation averages for a location) with the sample for Washington, D.C. (*slide 7).* If you wish to make a climatogram for your own location instead, see the detailed directions at the end of this Teacher Guide. Here is a good opportunity to check for what students remember about graphs. Things to point out:

- title
- two axes, with different scales
- units on the axes
- the key (precipitation and temperature are climate averages, measured over a long period)
- combination of bar graph for precipitation (total average rainfall per month, so discrete quantities) and line graph for temperature (continuous data)

To prepare students to look at the maps that include prevailing winds, show them the definition and diagrams relating to the term (*slide 8),* and then a sample map, also of Washington, D.C. (*slide 9*). These maps are similar to what students will see shortly in the exploration activity (see the document *GPM Geographical Influences on Climate – U.S. Cities Climatograms*). The shaded relief shows mountains in brown – you might point out the major ranges that are labeled. Large bodies of water (oceans, bays and large lakes) show in light blue – rivers and streams are not generally included.

The arrows show prevailing wind patterns. Prevailing wind data is usually collected at airports, and can be affected by local geographic features such as river valleys, hills, etc. In general, the U.S. is in a band of westerlies, meaning the overall prevailing winds in the U.S. are from west to east (or southwest to northeast) – for this activity we will rely on this simplification, although in reality it is much more complex. For a global diagram of prevailing winds, see http://kids.britannica.com/comptons/art-108062. If you would like to look up more precise prevailing winds patters, one source (for major U.S. cities only) is http://www.ncdc.noaa.gov/oa/mpp/wind1996.pdf. The map on the right is a zoomed-in version to allow students to see more detail. In the climatograms students will be looking at, the two comparison cities that are part of each group of three will also be marked.

Distribute climatograms to the students (ideally printed in color as a class set to be reused -you may need to give multiple students the same climatogram, based on your class size), and show the directions (*slide 10).* Students should use the climatogram given to them and the *GPM Geographical Influences on Climate – Student Capture Sheet* to calculate the averages and range for temperature and precipitation throughout the year, and describe any other patterns they see in the data. Using the given map, they should describe the geographic features that might affect their location –elevation, lakes or oceans, wind direction compared to oceans or mountains, latitude, etc. After students have time to complete the front side of the capture sheet, they will compare their data to that of other cities in a relevant grouping.

Each group of three cities focuses on one key aspect of geographical influences on climate – elevation, mountains and rain shadows, coastal versus inland, and being leeward or windward of large bodies of water. Later in this document there is a guide with questions for students to discuss about their group of locations in an effort to lead them to discover the influence each of these factors has on temperature and precipitation. Each group will have one primary factor responsible for differences, although weather and climate are complicated, so secondary factors will also be present.

It may be helpful to students to write the key numbers from their analysis (mean temperature, temperature range, and mean precipitation) so that they can physically rearrange the cards to look for patterns. See the Teacher Notes section below for a key to the calculations for the given cities, and some ideas about what students will hopefully observe in each grouping.

After students have time to compare climatograms, bring them back together to summarize their findings and make notes of important points (*slides 11-14)*. For general summaries for each factor, see the notes for each slide in the *GPM Geographical Influences on Climate – Presentation* or the *GPM Geographical Influences on Climate – Student Capture Sheet KEY* (available by sending a request through http://gpm.nasa.gov/education/contact).

Explain:
To apply what they've learned about the effects of geographic features, have students create their own climatogram for a location, and a description of how the climate is affected there. Directions for how to get precipitation data from MY NASA DATA and how to create a climatogram using Microsoft Excel are at the end of this document.

If you are running short of time, you can always have students use the *GPM Geographical Influences on Climate - Climatogram Template and City Data* rather than having them go through all the steps to create their own graph in Excel. As another time saver, if you would like to give students' prepared data rather than have them seek it out themselves, see the end of this document for data tables for various cities around the world. A good source for maps of U.S. cities on the computer is www.nationalatlas.gov/printable.html or www.nationalatlas.gov/mapmaker. For non-U.S. locations, try maps.nationalgeographic.com/maps/atlas-explorer.html. Students could digitally add a star to their location, and put it on the same page as their climatogram and descriptions. Prevailing wind direction can be tricky to find. Data for many U.S. cites can be found at www.ncdc.noaa.gov/oa/mpp/wind1996.pdf. or other possibilities, see under "Sources for Climate Data" below.

Evaluate:
See the end of this document for a rubric to evaluate the accuracy of the climatogram, map and descriptions. (Also in *GPM Geographical Influences on Climate – Student Capture Sheet.*)

Elaborate/Extend:

- Have students research additional data about the locations – cloud cover, aerosols, vegetation, etc. available from MY NASA DATA. As an example, Patterns in High Cloud Cover - http://mynasadata.larc.nasa.gov/lesson-plans/?page_id=474?&passid=87

- The end of the *GPM Geographical Influences on Climate – PowerPoint* (*slides 17-18*) shows a Landsat 5 false-color image of the rain shadow created by the Cascade Mountains in Oregon (http://earthobservatory.nasa.gov/IOTD/view.php?id=79247), along with an explanation in the notes. For more about how satellites get those images, see "How Landsat Images are Made," http://landsat.gsfc.nasa.gov/wp-content/uploads/2012/12/How2make.pdf. There is also a comparison of the false color image to a photograph/natural-color image from Google (*slide 19*), and natural color images (*slides 20 & 21*) of two other rain shadows in Bolivia (http://earthobservatory.nasa.gov/IOTD/view.php?id=8830) and Tanzania (http://earthobservatory.nasa.gov/IOTD/view.php?id=6014).

Re-teaching –

- An interactive summary of the geographical factors affecting climate: http://people.cas.sc.edu/carbone/modules/mods4car/ccontrol/index.html

Additional Resources:

- A high school level lesson similar to the first part of this lesson (having students use MY NASA DATA) can be found at http://mynasadata.larc.nasa.gov/lesson-plans/?page_id=474?&passid=102
- An alternate lesson for creating climatograms (also using MY NASA DATA) can be found at http://mynasadata.larc.nasa.gov/lesson-plans/?page_id=474?&passid=74

Teacher Notes:

City	State	Latitude	Longitude	Elevation (feet)	Elevation (meters)	Mean Precip. (mm/month)	Mean Precip. (inches/month)	Mean Temp. (°C)	Mean Temp. (°F)	Temp. Range (°C)	Group	Major Geographic Factor
Astoria	OR	46.2	-124	23	7	142.9	5.7	11	52	10	A	Mountains
Beacon Rock S.P.	WA	45.7	-122	848	258	164.7	6.6	12.1	54	17.0	A	Mountains
Pendleton	OR	45.7	-119	3623	1104	31.4	1.3	11.8	53.2	21.0	A	Mountains
Carson City	NV	39.2	-120	4802	1464	20.6	0.8	10.7	51.2	21.0	B	Mountains
San Francisco	CA	37.8	-122	52	16	50.4	2.0	14.3	57.7	6.0	B	Mountains
Yosemite N.P.	CA	37.8	-120	3996	1218	77.4	3.1	12.6	54.7	20.0	B	Mountains
Buffalo	NY	42.9	-78.9	635	194	85.9	3.4	9.2	48.5	26.0	C	Lake Effect
Cleveland	OH	41.5	-81.7	653	199	83.0	3.3	10.8	51.5	25.0	C	Lake Effect
Toledo	OH	41.7	-83.6	614	187	72.6	2.9	10.4	50.8	26.0	C	Lake Effect
Jackson	MS	32.3	-90.2	85	26	114.9	4.6	18.3	65.0	20.0	D	Coast/Inland
New Orleans	LA	30	-90	7	2	133.0	5.3	21.0	69.8	16.0	D	Coast/Inland
St Louis	MO	38.6	-90.2	466	142	91.3	3.7	9.1	48.4	26.0	D	Coast/Inland
El Paso	TX	31.8	-107	3888	1185	20.6	0.8	18.2	64.7	21.0	E	Coast/Inland
Houston	TX	29.8	-95.4	43	13	115.9	4.6	21.1	70.0	17.0	E	Coast/Inland
San Antonio	TX	29.4	-98.5	650	198	68.5	2.7	20.9	69.7	19.0	E	Coast/Inland
Denver	CO	39.7	-105	5300	1615	38.6	1.5	10.0	50.0	23.0	F	Elevation
Kansas City	MO	39.1	-94.6	910	277	82.8	3.3	13.8	56.9	28.0	F	Elevation
Vail	CO	39.6	-106	8022	2445	49.0	2.0	3.3	37.9	23.0	F	Elevation

Each set of three cities is chosen to have a primary factor for students to observe, but because weather is complicated, there are other factors that will have an effect. Some of these observations can be made with the graphs themselves, others are better noticed with the calculated averages and ranges from the table above. To shorten the time for the activity, you could add this information to the climatograms, although that will give students less practice analyzing the graphs themselves. Prevailing wind can be especially tricky, and was simplified somewhat to keep the climatograms easy to understand, so that may not always be helpful in the interpretation of the data. It's noted in the description below whenever wind patterns are particularly useful.

Group A: Mountains

Astoria is on the coast, receiving the middle amount of rain. Beacon Rock S.P. is on the windward side of the mountains, right where the warm, moist air starts to rise, cool and condense, so they get even more rain than Astoria. Pendleton is on the far side of the mountains in the rain shadow, so the precipitation drops off significantly. NOTE: The local prevailing wind patterns are somewhat affected by the Columbia River gorge, so the general W to E patterns in the U.S. are more helpful. As a secondary factor, students might notice that the range of temperatures increases the farther inland one goes.

Group B: Mountains
Similar to Group A, coastal San Francisco receives a moderate amount of rain, while Yosemite National Park on the windward side of the Sierra Nevada range receives more precipitation, and Carson City in the rain shadow receives significantly less precipitation. Again, the prevailing U.S. wind pattern of W to E may be more helpful than local conditions. A secondary factor to note is that San Francisco, with the lowest elevation and on the coast, has the highest mean temperature and the smallest range. Yosemite is the middle elevation, with the middle average temperature and a larger range from being inland. Carson City has the highest elevation and is further inland, leading to a lower mean temperature and slightly larger range of temperature.

Group C: Lake Effect
The differences here are subtle, and best seen with the averages. All three locations have a similar range of temperatures (inland, but on the lakeshore). Buffalo is slightly cooler on average, perhaps due to the prevailing winds off the water. That also increases the precipitation for Buffalo. The least amount of precipitation is in Toledo – the prevailing winds blow across the land first, creating drier conditions. NOTE: Cleveland could be left out and this set given as a pair instead of triad, to make the differences more apparent.

Group D: Coast/Inland
This grouping has some of the clearest differences, something to consider if you are differentiating your groups rather than randomly assigning them locations. New Orleans is on the coast, with the lowest latitude, which gives it the highest mean temperature and the smallest range. Jackson, further inland with slightly higher latitude, has the middle mean temperature and range. St. Louis, far inland and with the highest latitude, has the lowest mean temperature and the greatest range, as well as the lowest precipitation. Elevation could also play a factor – St. Louis has the highest elevation and by far the lowest mean temperature.

Group E: Coast/Inland
Similar to Group D, we progress from Houston on the coast with the smallest range of temperature and most precipitation. Further inland is San Antonio, with the middle numbers for temperature range, and precipitation. Even further inland is El Paso, with the lowest precipitation and highest range of temperatures. Elevation is a secondary factor affecting temperature – Houston at the lowest elevation has the highest mean temperature, San Antonio is in the middle with the middle mean temperature, and El Paso is the highest elevation with the lowest mean temperature. (Latitude is not a factor here, as all three are at roughly the same latitude.)

Group F: Elevation
The primary factor here is elevation, as all three cities have the same latitude. Kansas City is the lowest elevation and the highest mean temperature. Denver is in the middle with the middle mean temperature, and Vail is at a high elevation with the lowest mean temperature. The precipitation patterns may be tricky for students to see – Vail, compared to Denver, is clearly on the windward side of the Rocky Mountains, benefiting from the mountains causing the air to rise and condense, while Denver is in the rain shadow. Kansas City is far enough away to escape the effects of the rain shadow of the Rockies.

Guiding Questions for Comparing Locations Using Climate

Use these questions to help you look for patterns in the temperature and precipitation data for your three cities. It may help you to write the major averages you calculated (mean temperature, mean precipitation, and temperature range) on index cards with the city names, so that you can rearrange them as you go. Keep your mind open to see other patterns, beyond those the questions may guide you to.

Washington, D.C.
Mean temp.: 14.7 ˚C Temp. range: 25˚C Mean precip.: 84.3 mm/month

Remember, patterns in the data could be increasing, decreasing, or staying the same. Sometimes the pattern will be to increase and then decrease, or the reverse.

1. Are some of your cities next to water and others not? If so, put the cities in order by closest to the coast versus farthest away. Do you see any patterns in the data?
   ➔ (If all of your cities are next to water, skip this question.)

2. Put the cities in order by elevation. Do you see any patterns in the data?
   ➔ (If all of your cities are close to the same elevation, skip this question.)

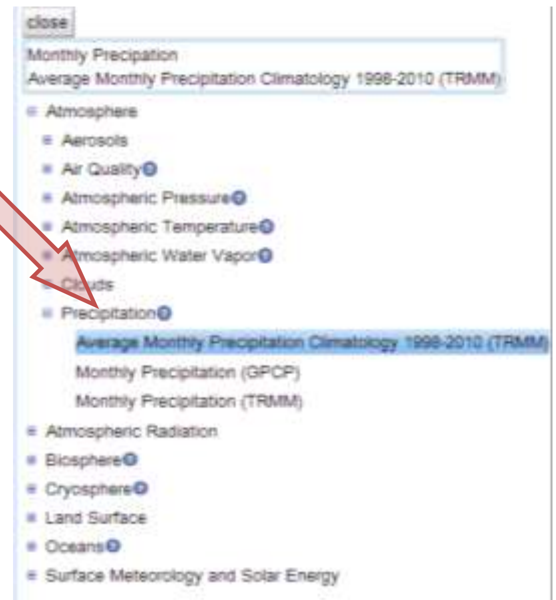
3. Are there mountains near your cities? If so, put the cities in order by their location, and use a pencil or something else to represent the mountains. Think about the prevailing wind direction, and whether the wind hits the city first and then the mountains, or if the city is "behind" the mountain in terms of wind. Do you see any patterns in the data?
   ➔ (If your cities are not near mountains, skip this question.)

4. Are your cities more than two degrees different in latitude? If so, put the cities in order by latitude. Do you see any patterns in the data?
   ➔ (If your cities are close in latitude, skip this question.)

5. Are there any differences in terms of prevailing wind – will some of your cities have the wind travel over land before getting to them and some have the wind travel over water first? If so, look for any patterns in the data this might create.

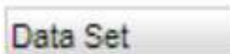
Directions to get TRMM precipitation data from MY NASA DATA:

1. Go to https://mynasadata.larc.nasa.gov/live-access-server/ and click on the link for the Live Access Server (Advanced Edition).

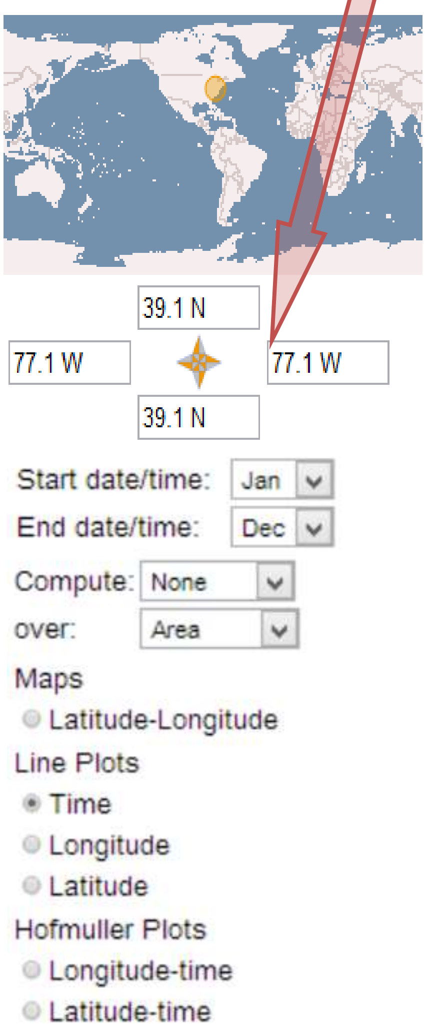


2. Choose *Atmosphere > Precipitation > Average Monthly Precipitation Climatology 1998-2010 (TRMM)*

   (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*.

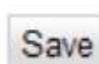


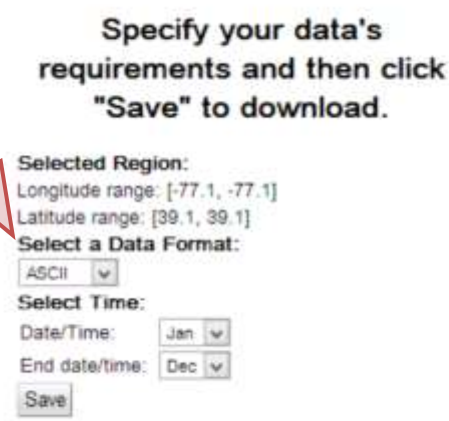
4. Click the *Update Plot* from the menu bar near the top.

5. We want a bar graph, 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 to open your document (you will probably need to open the program and find where the file is saved, rather than just double-clicking) and then copy and paste the data into the spreadsheet for graphing. See *How to Make a Climatogram* for graphing directions.

Sources for Climate Data:

NASA TRMM Data – see separate directions

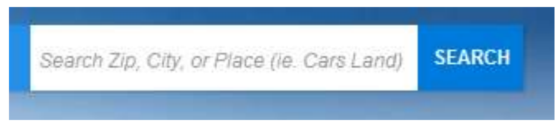
- ➔ Precipitation only, for latitudes 40˚N to 40˚S – won't work for further north or south

NOTE: TRMM data is mm/day, so you will need to multiply by the number of days in each month) in order to get a monthly amount.

www.weather.com

- ➔ Has U.S. cities and some international ones

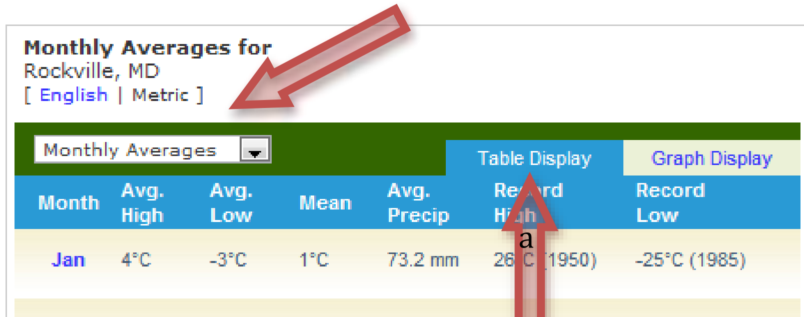
1. Enter your city name in the box.



2. Choose "Monthly" data from the left hand menu bar.

3. Scroll down and click the "Averages" button.

4. Make sure you select "Metric" and the "Table Display".



Other Sources to Try:

www.wunderground.com
- Will give latitude, longitude and elevation (feet only) for the given station. Has detailed history day-by-day, but not monthly averages, and only viewable in the U.S. system, not metric

http://www.intellicast.com
- Monthly averages are available in ˚C, but precipitation is only in inches. (Click on "Historic Averages" once you've searched for the city.)

http://www.climatedata.eu/
- Only has Europe and Africa, and only has highs and lows for temperature– you will need to calculate the average. Also includes hours of sunshine.

http://www.worldclimate.com/
- May need to use the city's name in its local form (ex: instead of Moscow, use Moskva). Make sure you select average temperature. Does have elevation.

http://www.bestplaces.net/climate/default.aspx
- Will require conversion to ˚C and mm (measurements in ˚ and inches), if you use it for that data. Includes snowfall data and average windspeed and direction.

http://www.climate-charts.com/
- Make sure you use the charts below with average (mean) temperature value, not highs or lows. Also has elevation data, and a graph of daylight (not hours of sunshine).

Maps:

- For U.S. locations, try www.nationalatlas.gov/printable.html or www.nationalatlas.gov/mapmaker
- For non-U.S. locations, try maps.nationalgeographic.com/maps/atlas-explorer.html

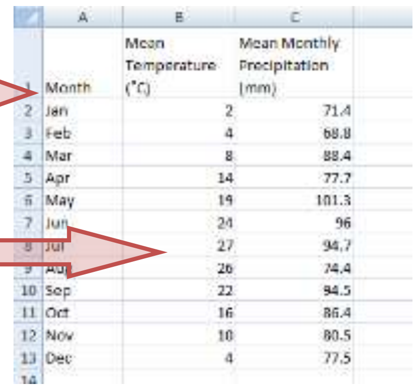
Winds:

- For detailed prevailing winds by location in the U.S.: www.ncdc.noaa.gov/oa/mpp/wind1996.pdf.
- For a very general map of worldwide prevailing winds: http://maps.howstuffworks.com/world-prevailing-winds-map.htm

How to Make a Climatogram:

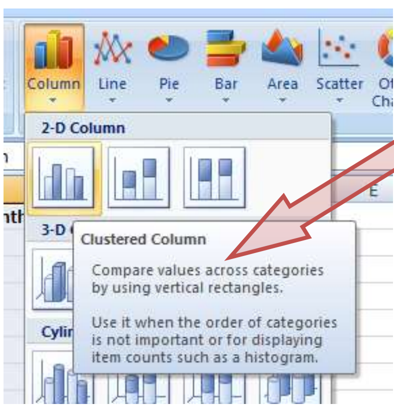
1. Collect temperature and precipitation data, from MY NASA DATA or another source. (See *How to Get TRMM Data from MY NASA DATA* for detailed directions for precipitation data.)
2. Open up an Excel spreadsheet.
3. Create three columns: **Month**, **Mean Temperature (˚C),** and **Monthly Precipitation (mm).** *NOTE: If you used NASA TRMM data, it is measured in mm/day, so you will need to multiply by the number of days in each month to get a monthly total.*

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

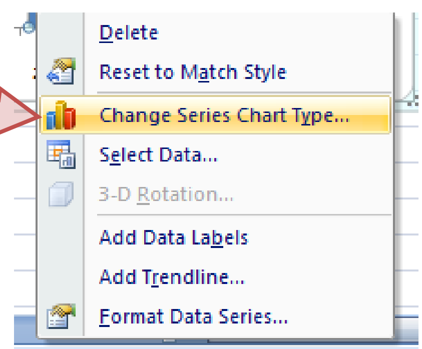


Month	Mean Temperature (°C)	Mean Monthly Precipitation (mm)
Jan	2	71.4
Feb	4	68.8
Mar	8	88.4
Apr	14	77.7
May	19	101.3
Jun	24	96
Jul	27	94.7
Aug	26	74.4
Sep	22	94.5
Oct	16	86.4
Nov	10	80.5
Dec	4	77.5

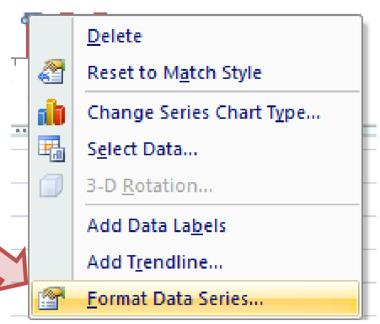
4. Enter the months in the first column. You can use the abbreviations from above, or type out the entire name.
5. Enter the data you collected into the chart. You won't use units in the data cells, since the columns indicate the unit. Your spreadsheet should look something like this: (data from Washington, D.C.)



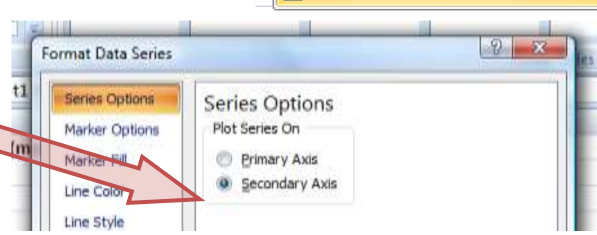
6. Select the entire area of your data, and create a 2-D Clustered Column graph.
7. Right click on the temperature data set, and choose "Change Series Chart Type."



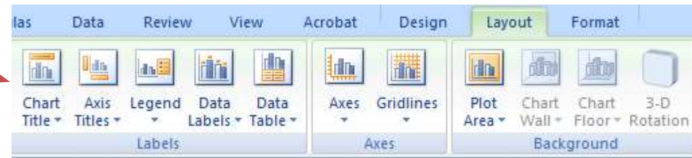
8. From the options, choose "Line with Markers."
9. Right click on the data set again, and choose " ormat Data Series."



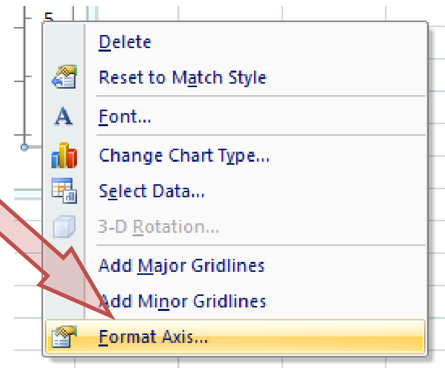
10. Choose "Series Options" and change the plot to the secondary axis. This menu is also where you can change the color of the line and the markers, if you would like to.

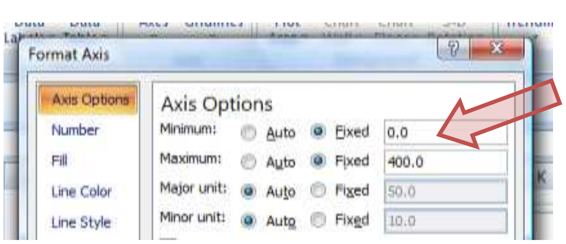


11. Using the Layout menu, add:
    - a title
    - axis labels (use your column headings and make sure you use units)
    - a key/legend (putting it at the top will take up less space.)
    - data labels (make sure you can see all the numbers)



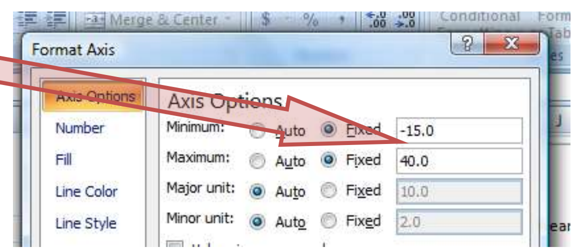
12. Right click on the Precipitation axis and choose “ ormat Axis.”



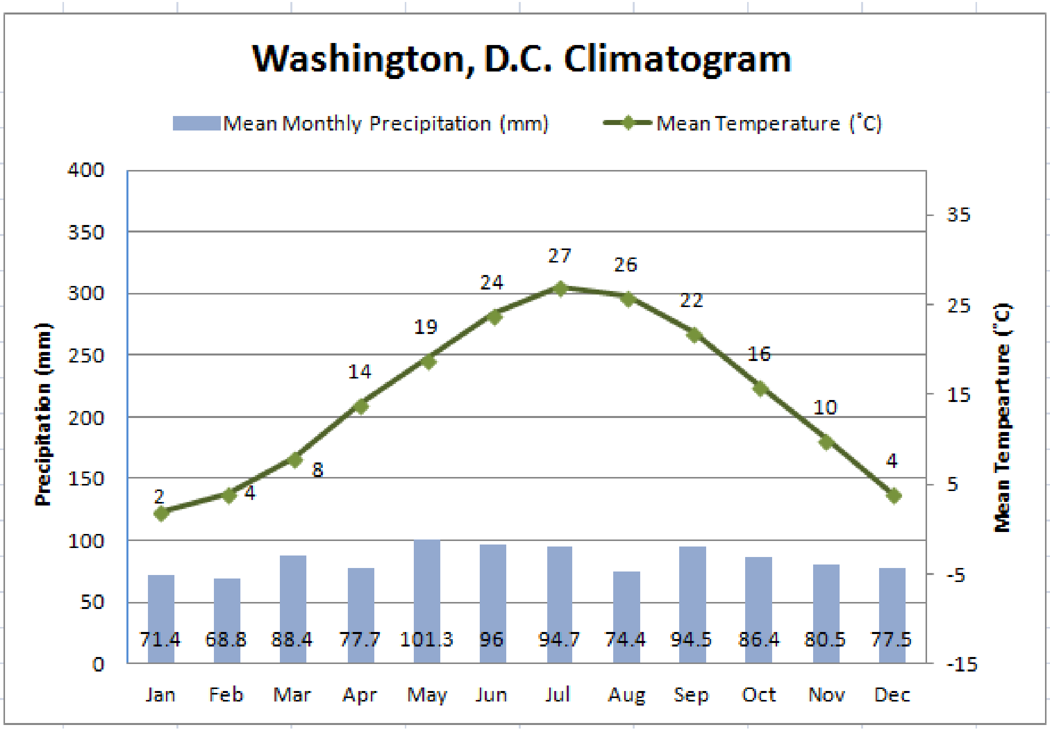


13. Change the minimum to be fixed at 0 and the maximum to be fixed at 400. (We want to be able to compare our graphs, so they all need the same scale.)

14. Right click on the Temperature axis and “ ormat Axis” to have a fixed minimum of -15 and a fixed maximum of 40.



Sample result:



Name: ______________________________ Date: ________________ Period: ________

Checklist and Rubric for Final Product: Climatogram, Map, and Descriptions

Climatogram:

Overall graph

___ Data is accurate and entered correctly *[3 points]*

___ Title (location name and description, ex: "Washington, D.C. Climatogram"

___ Key (both precipitation and temperature data)

Axis labels

___ Temperature (including units, ˚C)

___ Precipitation (including units, mm)

___ Months (correctly marked)

Axis formatting

___ Temperature axis is from -15 to 40

___ Precipitation axis is from 0 to 400 mm

Data labels

___ Precipitation – present and readable

___ Temperature – present and readable

Map:

___ Location correctly marked and labeled on map

___ Latitude listed

___ Longitude listed

___ Prevailing winds marked with arrow(s) *[2 points]*

___ Features (mountains, lakes, oceans etc.) drawn or labeled correctly. *[3 points]*

___ Elevation listed

Overall Score:

Climatogram:	____ / 12
Map:	____ / 9
Descriptions:	____ / 24
Total:	___ / 35
	_______ %

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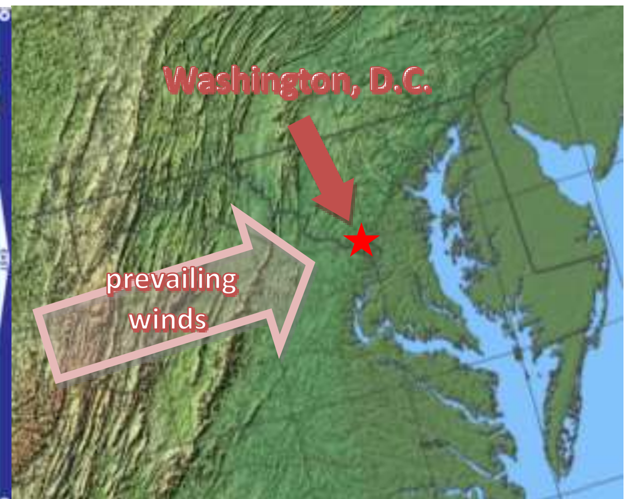
Descriptions:

Points	Precipitation	Temperature	Elevation	Geographic Effects of Water	Geographic Effects of Mountains	Overall Effect
4 (100%)	Description includes **yearly average** and **range** and **clearly** and **accurately** describes patterns in the data.	Description includes **yearly average** and **range** and **clearly** and **accurately** describes patterns in the data.	**Elevation data** is given, and the effect of that on temperature is **described clearly and accurately.**	Location of city in **relation to lakes and oceans** is described accurately, and the **effect of bodies of water on temperature and precipitation** is clearly explained.	Where the city is in **relation to mountains** is described, **prevailing wind direction** given, and the **effect of these on temperature and precipitation** is clearly explained.	**Excellent,** with very **clear description**, excellent use of **vocabulary**, and attention to correct **grammar and spelling.**
3.4 (85%)	Missing overall statistics, or with minor errors or lack of clarity.	Missing overall statistics, or with minor errors or lack of clarity	Missing elevation data, but description is accurate.	Overall good, but with minor errors in accuracy, or slight lack of clarity in description.	Overall good, but with minor errors in accuracy, or slight lack of clarity in description.	Good description, some use of science vocabulary, only minor errors in grammar and spelling.
3 (75%)	Some data is missing or inaccurate, or descriptions unclear, but the basic ideas come across.	Some data is missing or inaccurate, or descriptions unclear, but the basic ideas come across.	Some data is missing or inaccurate, or descriptions unclear, but the basic ideas come across..	Some data is missing or inaccurate, or descriptions unclear, but the basic ideas come across.	Some data is missing or inaccurate, or descriptions unclear, but the basic ideas come across..	Fair description, but minimal use of science vocabulary, and noticeable errors in grammar and spelling.
2.6 (65%)	Very unclear or confusing, or with major errors in content.	Very unclear or confusing, or with major errors in content.	Very unclear or confusing, or with major errors in content.	Very unclear or confusing, or with major errors in content.	Very unclear or confusing, or with major errors in content.	Poor description, no use of science vocabulary, and significant errors in grammar and spelling.
0	Not included	Not included	Not included	Not included	Not included	Incomprehensible

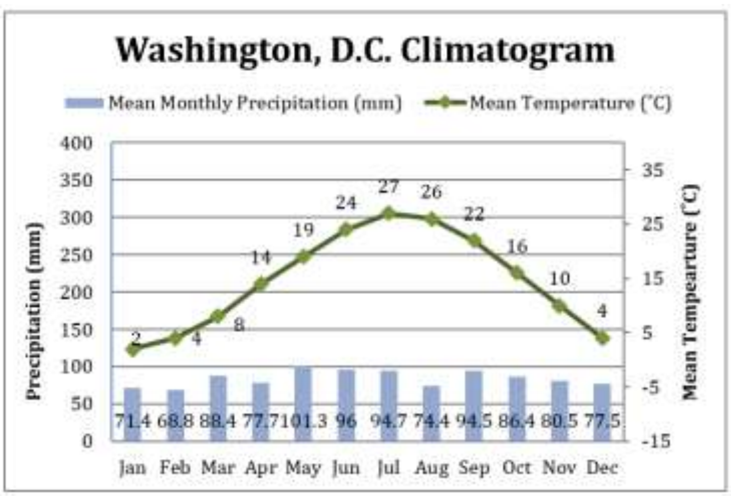
Sample Climatogram and Description: Washington, D.C.

Latitude 38.9 N, Longitude 77.0 W
Elevation: 62 meters (205 feet)



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

NOTE: Prevailing wind data is usually collected at airports, and can be affected by local geographic features such as river valleys, hills, etc. In general, the U.S. is in a band of westerlies, meaning the overall prevailing winds in the U.S. are from west to east (or southwest to northeast) – for this activity we will rely on this simplification, although in reality it is much more complex. For a global diagram of prevailing winds, see http://kids.britannica.com/comptons/art-108062.



Washington, D.C. gets an average of 84.3 mm of precipitation every month. Looking at the pattern of the data, it rains a lot most months, although the most is in May and June. There are not months where it doesn't usually rain much, although the least amount of precipitation is in January and February. The range of precipitation is 32.5 mm.

In terms of temperature, the average over the whole year is 14.7˚C, and the range is 25˚C, which is pretty large because Washington is not directly on the coast. The hottest months are July and August, and the coldest months are December, January and February.

Washington D.C. has a low elevation, only 62 meters, so there is not an effect of it being colder due to altitude. Washington is somewhat close to the Chesapeake Bay, but is not on the water, so it still has a high range in temperature between summer and winter – it's not close enough to be moderated by the water. The city is the leeward side of the Appalachian Mountains given the prevailing wind from the northwest most of the year, but it may be far enough away that there is not much of a rain shadow effect, since there still seems to be plenty of precipitation.