

Climate and Weather

To solve problems, scientists ask scientific questions. They determine the best methods to answer the question, collect the data, and analyze it to draw evidence-based conclusions that answer the question. You will be practicing these steps in the process of science in this lab.

Learning objectives:

- Students will be able to identify factors that affect climate and distinguish climate and weather.
- Students will be able to apply and analyze steps in the **process of science** (scientific literacy).
- Students will be able to calculate **percentage** (quantitative literacy).
- Students will be able to distinguish between **observations and interpretations** (scientific literacy).

Materials needed:

- Access to [TimeandDate.com](https://www.timeanddate.com) (<https://www.timeanddate.com>)

Part 1: Navigating the Time and Date Website

Go to the [TimeandDate.com](https://www.timeanddate.com) website and click on the “Weather” tab. Search for a city or place that is meaningful to you , or choose a city from the list. Read the tabs at the top (e.g., “Weather Today”), and scroll down to see what other information is on the page.

1. Which link would you follow to learn about the weather next week?

- ☐ Weather Hourly
- ☐ 14 Day Forecast
- ☐ Yesterday/Past Weather
- ☐ Climate (Averages)

? Was the high temperature on the 4th of July last year different than the July average in my location?

Imagine you are trying to answer the question above. To determine the high temperature on the previous 4th of July, go to the “Yesterday/Past Weather” tab. Then, to choose the month of July and the year in the pull-down menu “Select month:” on the right. To find July 4th, either click the large, blue arrows on the left side of the graph or select the date under the graph. Record the high temperature in Data Table 1. To determine the average temperature, select “Climate (Averages).” Record the average high temperature in July in Data Table 1.

Data Table 1

Location	Last Year (°)	July Average (°)

2. Subtract last year's temperature from the July average to calculate the difference in temperature.

_____ °

Weather is the day-to-day state of the atmosphere, and climate is the long-term average of weather conditions over decades.

3. Do the columns in Data Table 1 relate to climate or weather?

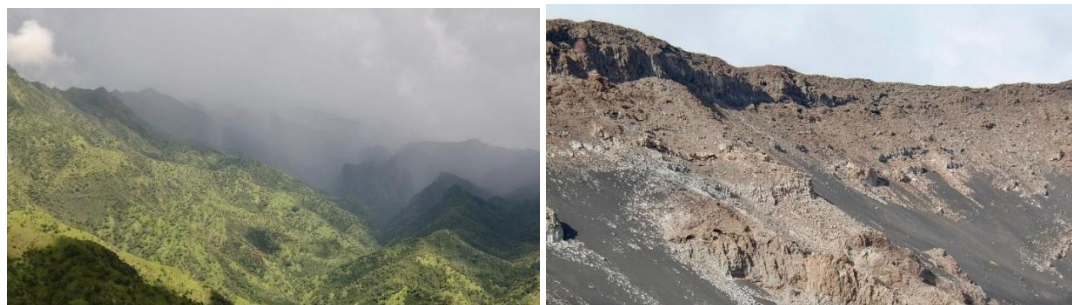
- ☐ Last Year and July Average both relate to weather.
- ☐ Last Year and July Average both relate to climate.
- ☐ Last Year relates to weather; July Average relates to climate.
- ☐ Last Year relates to climate; July Average relates to weather.

Distinguishing between **observations and interpretations** is an important skill for scientists that you will practice below. Observations are what you can see or measure. Interpretations are explanations that make sense of observations. Observations are data, and interpretations are conclusions made from that data.

4. Each choice below is either an **observation or interpretation**. Which of these is an **interpretation** of temperature data?

- ☐ The clouds trapped heat overnight keeping the temperature high.
- ☐ In Denver, Colorado, the high temperature on April 8 was 72°.
- ☐ The temperature dropped 10° in three hours.
- ☐ The average temperature in Providence, Rhode Island is higher in August than September.

Part 2: Collecting data about rain shadows



Both pictures are of Hawaii, but the left one shows rain on a green landscape, and the right one shows a dry, rocky landscape. (source: Majaranda on pixabay.com)

? How does the average annual rainfall on the upwind side of a mountain range compare to the downwind side?

Consider the scientific question above about the rainfall on opposite sides of a mountain. Using the TimeandDate.com website, you will collect data to answer the question. The methods to follow have been figured out for you, but you will collect the data and analyze it to use as evidence to critically think about the conclusion proposed below.

Data Table 2 below lists cities on either side of a mountain range. Fill in the annual precipitation found in the “Quick Climate Info” in the Climate (Averages) section of the TimeandDate.com website. Do not fill in the % column yet.

Data Table 2

Mountain Range	Upwind City	Annual Precipitation	%	Downwind City	Annual Precipitation	%
Cascades	Seattle, WA	30.84”		Spokane, WA	15.65”	
Cascades	Eugene, OR			Bend, OR		
Mauna Loa	Hilo, HI			Kailua-Kona, HI		
Sierra Nevada	Sacramento, CA			Reno, NV		

5. Which side of a mountain range has more rainfall?

- ☐ Eastern side
- ☐ Western side
- ☐ Upwind side
- ☐ Downwind side

6. Which **two cities have the lowest annual precipitation?**

- | | |
|-------------------------------------|--------------------------------------|
| ☐ Seattle | ☐ Spokane |
| ☐ Eugene | ☐ Bend |
| ☐ Hilo | ☐ Kailua-Kona |
| ☐ Sacramento | ☐ Reno |

Scientists calculate **percentages** to make data easier to compare and communicate. Percentages show how big something is relative to the total number. To calculate a percentage, take the number that you

identified (the part you want to know about) and divide it by the total number identified, and multiply that by 100.

For each pair of cities, calculate the **percentage** of rain that falls in each city. Use the sum of the precipitation in both cities for the total number (whole). For example, for the two cities in Washington the total precipitation is $30.84'' + 15.65'' = 46.49''$ total. To calculate the percentage in Seattle, divide the part ($30.84''$) into the whole ($46.49''$), and multiply by 100, giving 66% of the rain falling in Seattle. Doing the same for Spokane gives 34% falling in Spokane ($15.65'' / 46.49'' * 100$). Fill in Data Table 2, above.

Note the two numbers below used to calculate the percentage of rain that falls in Hilo:

Your note: The part you want to know about _____ Total number _____

7. What is the **percentage** of rain that falls in Hilo? _____ %

8. Which **two** cities have the lowest **percentage** of precipitation because of the strongest rain shadow effect?

- | | |
|-------------------------------------|--------------------------------------|
| ☐ Seattle | ☐ Spokane |
| ☐ Eugene | ☐ Bend |
| ☐ Hilo | ☐ Kailua-Kona |
| ☐ Sacramento | ☐ Reno |

Do some brief independent research to learn about why rain shadows occur. In your research, find a diagram with labels that step the reader through the processes involved.

9. Each choice below is either an **observation or interpretation**. Which of these is an **interpretation**?

- ☐ As ocean air rises over a mountain range, it cools and precipitates on the upwind side.
- ☐ The upwind side of the mountain range gets an average of 78% of the precipitation.
- ☐ Mountain ranges farther south have a more uneven percentage of precipitation.
- ☐ There is 31" of precipitation in Seattle and 16" in Spokane.

10. Based on your data, how would you describe the rain shadow effect?

- ☐ Areas upwind of a mountain range get less precipitation as the air goes around the mountain, and the air picks up water to precipitate on the other side.
- ☐ Areas upwind of a mountain range get 100% of the precipitation as the air hits the mountain and cannot reach the other side.
- ☐ Areas upwind of a mountain range get 50% of the precipitation as the air goes around the mountain, and it rains the other 50% on the other side.
- ☐ Areas upwind of a mountain range get more precipitation as the air rises over the mountain and cools, and the air is drier on the other side.

Examine the 14-day forecast for Hilo, HI and Kailua-Kona, HI. Record the inches of rain expected each day for the next 10 days in Data Table 3.

Data Table 3

	1	2	3	4	5	6	7	8	9	10	Total
Hilo											
Kailua-Kona											

Add the rain for all 10 days to determine the total rainfall for each location. Calculate the **percentage** of rain in Hilo and in Kailua-Kona compared to the total rainfall for both locations.

Hilo, HI: Percentage of inches of rain _____

Kailua-Kona, HI: Percentage of inches of rain _____

11. Which city had a higher **percentage** of rain?

- ☐ Hilo, but the amount of rain was close, with the two percentages close to 50%.
- ☐ Hilo, and the two percentages are very different.
- ☐ Kailua-Kona, but the amount of rain was close, with the two percentages close to 50%.
- ☐ Kailua-Kona, and the two percentages are very different.

12. Each choice below is either an **observation** or **interpretation**. Which of these is an **observation**?

- ☐ Kailua-Kona has fewer days with clouds than Hilo.
- ☐ You would be more likely to get a sunburn in Kailua-Kona than Hilo.
- ☐ Kailua-Kona would have more tropical plants and less desert-like plants than Hilo.
- ☐ There would be more water in the ground in Kailua-Kona than Hilo.

13. Do the percentages you calculated relate to climate or weather?

- ☐ Percentage annual precipitation and percentage inches of rainfall both relate to weather.
- ☐ Percentage annual precipitation and percentage inches of rainfall both relate to climate.
- ☐ Percentage annual precipitation relates to weather; percentage inches of rainfall relates to climate.
- ☐ Percentage annual precipitation relates to climate; percentage inches of rainfall relates to weather.

Part 3: Analyzing data about sunny days

? How often is it sunny in August in Los Angeles, CA?

To answer the question above about sunny days in Los Angeles, a student collected data for the first two weeks in August, 2025 and filled in Data Table 4.

Data Table 4

August, 2025	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Los Angeles	Sun	Sun	Sun	Sun	Sun	Sun	Sun	Sun	Sun	Sun	Sun	Sun	Sun	Cloud

14. How would you calculate the **percentage** of sunny days to analyze the data in Data Table 4?

- ☐ I would take the total number of sunny days, subtract that by the number of cloudy days, and multiply that by 100.
- ☐ I would take the number of sunny days, divide that by the total number of days, and multiply that by 100.
- ☐ I would take the number of sunny days, add them together, and multiply that by 100.
- ☐ I would take the number of sunny dates, divide that by the number of cloudy days, and multiply that number by 100.

15. Calculate the **percentage** of sunny days for two weeks in August in Los Angeles using the student's data in Data Table 4. _____%

16. Do the scientific question and the student's data describe climate or weather?

- ☐ The scientific question and the student's data both describe weather.
- ☐ The scientific question and the student's data both describe climate.
- ☐ The scientific question describes weather; the student's data describes climate.
- ☐ The scientific question describes climate; the student's data describes weather.

17. You review the student's methods as a peer reviewer. Select **two** ways to improve their methods.

- ☐ Use the information to calculate the average number of hours of sun each day.
- ☐ Look at the entire month of August, since the first half might be different than the second half.
- ☐ Look at August in different years, since in a single year there might be storms that affect how sunny it is.
- ☐ Collect data for July and September, in addition to August, since August may be an unusual month.
- ☐ Collect data for cities near Los Angeles, such as Santa Monica, Pasadena, and Pomona, since Los Angeles may be an unusual city.

Part 4: Analyzing data about temperature near the ocean

? How does being near the ocean affect the range of annual temperatures?

A student collects the following data in Data Table 5 to answer the question above about the ocean's effect on temperatures. The student identified five pairs of cities, with one city at the coast and one city nearby, but inland. They collected data related to the temperatures and filled in Data Table 4.

Data Table 5

City (Coastal)	Average summer high (°F)	Average winter low (°F)	Range (°F)	City (Inland)	Average summer high (°F)	Average winter low (°F)	Range (°F)
Santa Cruz, CA	74	40	34	San Jose, CA	81	42	39
Crescent City, CA	65	40	25	Yreka, CA	93	26	67
Virginia Beach, VA	88	33	55	Richmond, VA	90	29	61
Nantucket, MA	76	26	50	Hartford, CT	85	21	64
Houston, TX	94	46	48	Shreveport, LA	95	37	58

18. What part of the **process of science** did the student do while filling out the temperature columns in Data Table 5?

- ☐ Ask a scientific question
- ☐ Determine the methods to use
- ☐ Make observations and collect data
- ☐ Analyze data and develop conclusions
- ☐ Share results and conclusions

19. What data should you analyze in Data Table 5 to answer the scientific question?

- ☐ I looked at the average summer high and found they were all higher than the average winter low for each city.
- ☐ I looked at the range for each pair of cities and found the range of the coastal city was smaller than the inland city.
- ☐ I compared the cities on the West Coast to the cities on the East Coast, and found they were generally cooler in the summer and warmer in the winter.
- ☐ I looked at the average summer high and found there was no pattern, with some coastal cities having a higher temperature and some inland cities having a higher temperature.
- ☐ I looked at the range for all cities, calculated the average, and found it was 50°F.

20. Would it be useful to calculate a **percentage** to analyze the data in Data Table 5?

- ☐ Yes, it would be useful to calculate the percentage of each city's high and low temperatures compared to the range.
- ☐ Yes, it would be useful to calculate the percentage of the range for each pair of cities.
- ☐ No, because percentages are useful to analyze parts of a whole, and there is no whole here.
- ☐ No, because the numbers add up to more than 100.

21. Each choice below is either an **observation or interpretation**. Which of these is an **interpretation** that can be made about the data in Data Table 4?

- ☐ The average summer high is higher for inland cities.
- ☐ The average winter low is lower for inland cities.
- ☐ The ocean regulates the temperature of coastal cities.
- ☐ The range between summer and winter is smaller for coastal cities.

22. Select the data-based conclusion that best answers the scientific question above regarding how oceans affect temperature.

- ☐ Coastal locations have a higher summer temperature than inland locations.
- ☐ Coastal locations in California are more strongly affected by the ocean than locations in the East.
- ☐ Coastal locations have a smaller annual range in temperature than inland locations.
- ☐ Coastal locations have a higher winter temperature than inland locations.

23. Based on the data, how would you explain the difference in temperature for coastal and inland locations?

- ☐ The ocean does not change temperature as quickly as the land, so it helps to keep coastal locations cooler in the summer and warmer in the winter.
- ☐ The ocean changes temperatures dramatically with the seasons, so it helps to heat coastal locations more in the summer and less in the winter.
- ☐ The ocean wind blows towards land, so it helps to cool coastal locations in the summer as well as the winter.
- ☐ The ocean causes storms to hit the land, so it helps to cool coastal locations in the winter but does not affect them in the summer.

24. You check the Time and Date website, and you see that Santa Cruz, CA had an average low temperature of 52° for the first week of January in 2026. What can you interpret from this observation?

- ☐ The interpretation about the ocean affecting temperatures is incorrect as that would make the ocean range smaller than the inland range.
- ☐ The wind may have come from a different direction, bringing unusually warm air, as weather will vary and climate is a longer-term average.
- ☐ The climate numbers need to be updated, as this is clearly warmer than the previous years.

Part 5: Planning methods to answer a scientific question

- ❓ **How is the average high temperature in the summer affected by the latitude of the location?**

The methods section of a research report gives the specific step-by-step strategy used to collect data to answer a scientific question. You are asked the above scientific question about temperatures and latitude. What methods would you use to collect data to answer the scientific question? You are just figuring out a plan, and you will not collect the data.

Here are the steps (out of order) to answer the scientific question. Put the steps in order (Step 1, Step 2, etc.).

- Use a map to identify a city at each of the lines of latitude 5° apart. Choose cities that are far from the effects of oceans or rain shadows.
- Go to the Time and Date website for each city. Find the data for average high temperature for each city, and fill in the data in the table.
- Create a table to record the data, with the columns labeled “City,” “Latitude,” and “High summer temperature.” Fill in the cities and their latitudes.

25. What is Step 1?

26. What is Step 2?

27. What is Step 3?

A fellow student used the methods you planned above and collected the data in Data Table 6.

Data Table 6

Latitude	City	High summer temperature
30°N	Austin	98°
35°N	Amarillo	93°
40°N	Lincoln	89°
45°N	Minneapolis	84°
50°N	Winnipeg	81°

28. Each choice below is either an **observation** or **interpretation**. Which of these is an **interpretation** of the data shown in Data Table 6?

- ☐ The cities are alphabetical, with “A” in the south and “W” in the north.
- ☐ For every 5 degrees farther south, the high summer temperature increases by about 4°.
- ☐ Cities that are further north have cooler summer temperatures.
- ☐ Locations further south have more direct sunlight in the summer.

29. What part of the **process of science** does would happen next after you complete the previous question about Data Table 6?

- ☐ Ask a scientific question
- ☐ Determine the methods to use
- ☐ Make observations and collect data
- ☐ Analyze data and develop conclusions
- ☐ Share results and conclusions

There are many ways to share results and conclusions (e.g., graphs on slide presentations, paragraphs in a research report, podcasts, museum displays, websites, social media postings, etc.). Choosing the best way to communication depends on what is being presented and who is the audience.

Part 6: Determining how to answer scientific questions

Below are scientific questions (Questions A-E) that you will use to answer questions in Part 6.

- **Question A. “Which of the 10 largest cities in the United States has the coolest summer temperature?”**
- **Question B. “What was the weather like in Denver, Colorado for the past week?”**
- **Question C. “What is the rainiest month to visit Flagstaff, Arizona?”**
- **Question D. “What is the relationship between a city’s elevation and temperature?”**
- **Question E. “How many snowy days were there in Nashville, Tennessee last year?”**

Read this evidence-based conclusion statement:

“Cities with high elevations, like Flagstaff, Arizona, tend to have cooler temperatures throughout the year than cities with low elevations, like Phoenix, Arizona.”

30. Which of the scientific questions (Questions A-E above) is related to this conclusion statement?

- ☐ Question A ☐ Question B ☐ Question C ☐ Question D ☐ Question E

Read the following Methods Section that describes the plan to answer a scientific question:

- 1) Create a table with 10 rows. The header of the columns are “City” and “Average summer temperature”.
- 2) Identify 10 cities that fit the criteria and fill in the first column.
- 3) Collect temperature data on TimeandDate.com website for each city, and fill in the second column.

31. Which of the scientific questions (A-E, above) is answerable using these methods?

- ☐ Question A ☐ Question B ☐ Question C ☐ Question D ☐ Question E

Read Data Table 7:

Data Table 7

Month	Precipitation	Month	Precipitation	Month	Precipitation
January	2.1"	May	0.81"	September	1.89"
February	2.25"	June	0.32"	October	1.55"
March	1.77"	July	2.82"	November	1.39"
April	0.93"	August	3.14"	December	2.01"

32. Which of the scientific questions (A-E, above) would need a table like Data Table 7?

- ☐ Question A ☐ Question B ☐ Question C ☐ Question D ☐ Question E

Part 7: Synthesizing the Process of Science

? How is the average low temperature in the winter affected by longitude in the US?

You and a fellow student are asked to write a research report answering the above scientific question about temperatures at different longitudes. You use Time and Date.com to fill out the table.

The other student wrote the **first sentence** of your report:

We will examine how temperature is affected by longitude across the United States.

33. What is the primary part of the **process of science** that this **first sentence** describes?

- ☐ Ask a scientific question
☐ Determine the methods to use
☐ Make observations and collect data
☐ Analyze data and develop conclusions
☐ Share results and conclusions

34. Which sentence is a good **second sentence** for your report?

- ☐ We picked 6 locations with a variety of longitudes, latitudes, and elevations.
☐ The 6 locations we chose were all about the same population and had similar longitudes.
☐ After we drew the table we concluded that the cities in the west were warmer than the cities in the east.
☐ We chose 6 locations, each at a different longitude, but all near the same latitude.

Following your methods, the other student chose the locations, created Data Table 8, and filled in some of the data.

Data Table 8

Longitude	City	Low winter temperature (°)
120°W	City of Klamath Falls, Oregon	
110°W	Salt Lake City, Utah	
100°W	Kearney, Nebraska	
90°W	Chicago, Illinois	20
80°W	Buffalo, New York	19
70°W	Boston, Massachusetts	24

Collect the rest of the data for Data Table 8 and answer the following question.

35. Which is a good **third sentence** for your report?

- ☐ The temperatures ranged from a maximum of 24° to a minimum of 19°.
- ☐ The temperatures ranged from a maximum of 26° to a minimum of 15°.
- ☐ The temperatures ranged from a maximum of 30° to a minimum of 18°.
- ☐ The temperatures ranged from a maximum of 120° to a minimum of 70°.

36. Why is this a good sentence at this point in the report?

- ☐ It is asking scientific questions.
- ☐ It is describing the methods.
- ☐ It is collecting the data.
- ☐ It is describing the observed data.
- ☐ It is developing conclusions by interpreting the data.

37. Which is a good **fourth sentence** for your report?

- ☐ As you move from west to east, the temperatures of the cities trend upward.
- ☐ As you move from west to east, the temperatures of the cities trend downward.
- ☐ As you move from west to east, the temperatures varied and did not trend in a single direction.

38. Which sentence is a good **final sentence** for your report?

- ☐ Therefore, I conclude that Earth's rotation causes cities in the west to be cold, and cities in the east to be warmer.
- ☐ Therefore, I conclude that Earth's rotation causes cities in the west to be warm, and cities in the east to be colder.
- ☐ Therefore, I conclude there is no direct relationship between longitude and temperature.

39. Why was this an appropriate sentence for the end of your report?

- ☐ This sentence states the scientific question.
- ☐ This sentence describes the details of how to collect the data.
- ☐ This sentence makes an observation about the data.
- ☐ This sentence ties the interpretation of data to the original scientific question.

The student you are working with notices that the temperatures for the inland cities are generally colder in the winter than the cities near the coasts. Based on data you previously analyzed, how would you explain this observation?

40. Why are cities in the center of the US colder in the winter than cities on the East and West Coasts at the same latitude?

- ☐ Cities on the coasts have warmer temperatures than cities in the center because of their proximity to the ocean.
- ☐ Cities on the coasts are warmer in the winter than cities in the center because of their extreme longitude locations.
- ☐ Cities in the center of the country have colder temperatures because they have a higher latitude and are farther north.
- ☐ The temperatures of the cities match with their alphabetical order of the state they are in.

Reflection

41. Which question in this lab connects to your personal experience? Consider the lab topic, math skills, and the process of science. You may also consider your lived experience or stories you've encountered. To earn credit, list the question number and explain how it relates in 2-3 sentences.