Excerpt from *EDC Earth Science*
Chapter 4 | Looking at Climate Data

Teacher Guide to Activities

Purpose

This activity is designed to help students understand climate through studying data. By the end of the activiy, students should know that climate is defined as a long-term (30 years or more) average of weather conditions of a place or area., and that climate is measured primarily in terms of temperature and precipitation, although scientists also track other components of weather.

Students ask questions, analyze and interpret data, use mathematics and computational thinking, learn about patterns and stability and change (NGSS: ESS2.D.1).

Contents

Data Learning Objective

The student will relate and compare climate data in tables and graphs.

Description

Students learn about the difference between weather and climate. This activity has the students compare other climates to their own climate using data. The students practice reading graphs and tables.

LAB-AIDS Experiencing Science

Looking at Climate Data

Climate is the average weather conditions of a region over the long term (averaged over 30 years). Many weather conditions—temperature, amount of rain and snow, number of sunny days, and so on—can vary from place to place. Scientists have been tracking these conditions for some time, and you can obtain up-to-date tables and graphs of these data for all parts of the United States on the Internet from organizations such as the National Climatic Data Center (NCDC). To get you thinking about what climate is, how it is measured, and why it varies from place to place, you will study graphs in this activity that show the average annual temperature and precipitation in two parts of the United States: New Hampshire and Arizona. Then you will compare the climate of these two regions with your own and that of a travel destination of your choice.

Procedure

Record your observations and ideas in your notebook as you complete the following steps.

1. Study the temperature data for New Hampshire in the graph in Figure 4.4. Each black dot on the graph represents the average temperature in a given year. These dots are connected with blue lines to more clearly show their sequence.
   a. Which 3 years had the highest average annual temperatures in NH? What were these average temperatures?
   b. Which 3 years had the lowest average annual temperature in NH? What were these average temperatures?
   c. Can you find 2 years in a row that had very similar average temperatures? List the 2 years, and their average temperatures.

Materials

FOR EACH STUDENT

- data regarding the climate in your area and in your travel destination (your teacher will talk to you about how to obtain this information)

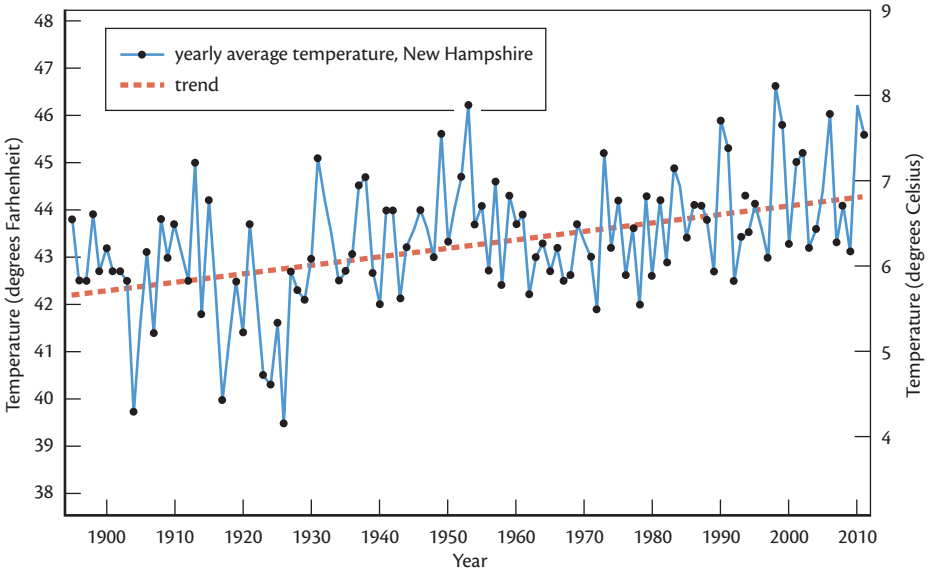

FIGURE 4.4
Graph showing annual average temperatures between 1895 and 2011 in New Hampshire.

d. Can you find 2 years in a row that had very different average temperatures? List them, and their average temperatures.

e. Because the average temperature varies so much from year to year in a region (like the weather varies from day to day) you have to look at a long-term trend, such as this 100+ year period, to see if there is a change in climate occurring. A trend line has been added to the graph in Figure 4.4 in red. This line is based on a running average that smooths out the jagged curve of annual averages into an overall trend. Do you see a trend in this graph? Write a sentence that describes what the trend line shows.

2. Study the temperature data for Arizona in Figure 4.5.

a. Which 3 years had the highest average annual temperatures in Arizona? What were these temperatures?

b. Which 3 years had the lowest average annual temperature in Arizona? What were these temperatures?

c. How do these highest and lowest average annual temperatures compare with those of New Hampshire?

d. Each point on the temperature graph represents an average for the given year. How would this graph look different if monthly or daily averages were presented instead?

e. You should have noticed that the temperature scale on the y-axis of the Arizona graph is different from the temperature scale on the New Hampshire graph. Why do you think these are presented differently?

f. Compare the annual temperatures curve in Arizona with the annual temperature curve in New Hampshire during the same time period. In what ways is the shape of the curves similar? In what ways are they different?

g. What is the overall trend in average annual temperatures in Arizona over the period from 1895 to 2011?

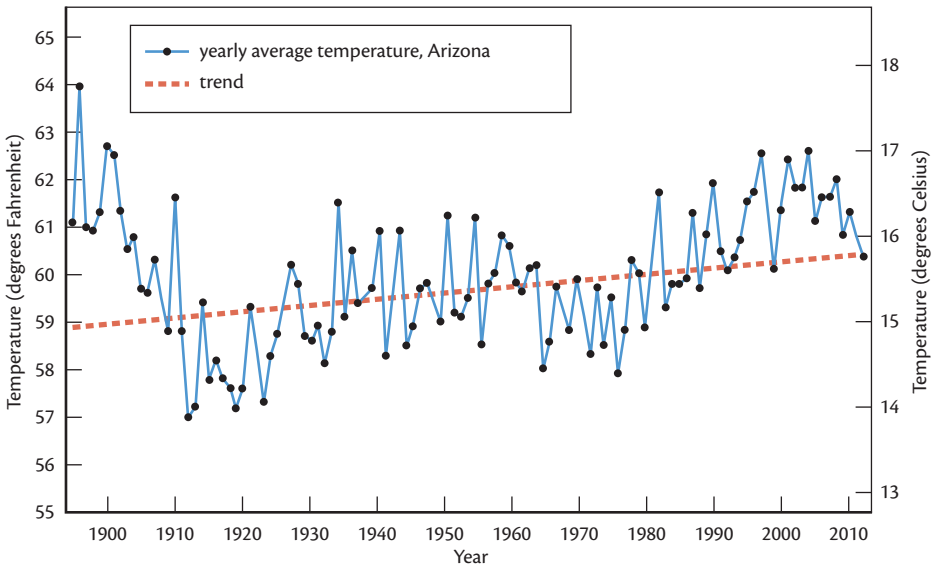

FIGURE 4.5
Graph showing annual average temperatures between 1895 and 2011 in Arizona.

3. Study the temperature data for New Hampshire and Arizona between 1976 and 2011 in Tables 4.1 and 4.2. Calculate the average temperature for each state over this entire time period.
   a. Which state had the highest average temperature during this 30+ year time period?
   b. Based on what you know about New Hampshire and Arizona, what are your ideas about why the average temperature is different in these two states? (Just do your best thinking about this—you'll explore this question later in the chapter).

Table 4.1: Average Annual Temperatures in New Hampshire Between 1976 and 2011[1]

YEAR	AVERAGE TEMPERATURE (degrees Fahrenheit)	YEAR	AVERAGE TEMPERATURE (degrees Fahrenheit)
2011	45.6	1993	43.4
2010	46.2	1992	42.5
2009	43.1	1991	45.3
2008	44.1	1990	45.9
2007	43.3	1989	42.7
2006	46.0	1988	43.8
2005	44.4	1987	44.1
2004	43.6	1986	44.1
2003	43.2	1985	43.4
2002	45.2	1984	44.5
2001	45.0	1983	44.9
2000	43.3	1982	42.9
1999	45.8	1981	44.2
1998	46.6	1980	42.6
1997	43.0	1979	44.4
1996	43.6	1978	42.0
1995	44.1	1977	43.6
1994	43.5	1976	42.6

Table 4.2: Average Annual Temperatures in Arizona Between 1976 and 2011[2]

YEAR	AVERAGE TEMPERATURE (degrees Fahrenheit)	YEAR	AVERAGE TEMPERATURE (degrees Fahrenheit)
2011	60.4	1993	60.7
2010	60.8	1992	60.3
2009	61.3	1991	60.1
2008	60.8	1990	60.5
2007	62.0	1989	61.9
2006	61.6	1988	60.8
2005	61.7	1987	59.7
2004	61.1	1986	61.3
2003	62.6	1985	59.9
2002	61.9	1984	59.8
2001	61.8	1983	59.8
2000	62.4	1982	59.3
1999	61.5	1981	61.7
1998	60.1	1980	60.4
1997	61.2	1979	58.9
1996	62.5	1978	60.0
1995	61.7	1977	60.3
1994	61.5	1976	58.9

4. Study the precipitation data for New Hampshire and Arizona between 1976 and 2011 in Figures 4.6 and 4.7, and Tables 4.3 and 4.4. Answer the following questions:
   a. Write down three observations about the average annual precipitation curve in the two states (represented by the black points with connecting green lines).
   b. Compare the trend in precipitation in the two states over the 100+ year period.
   c. Using the data in Tables 4.3 and 4.4, compute the average precipitation in each of the states between 1976 and 2011. Which state has the highest average precipitation over this 30+ year time period?

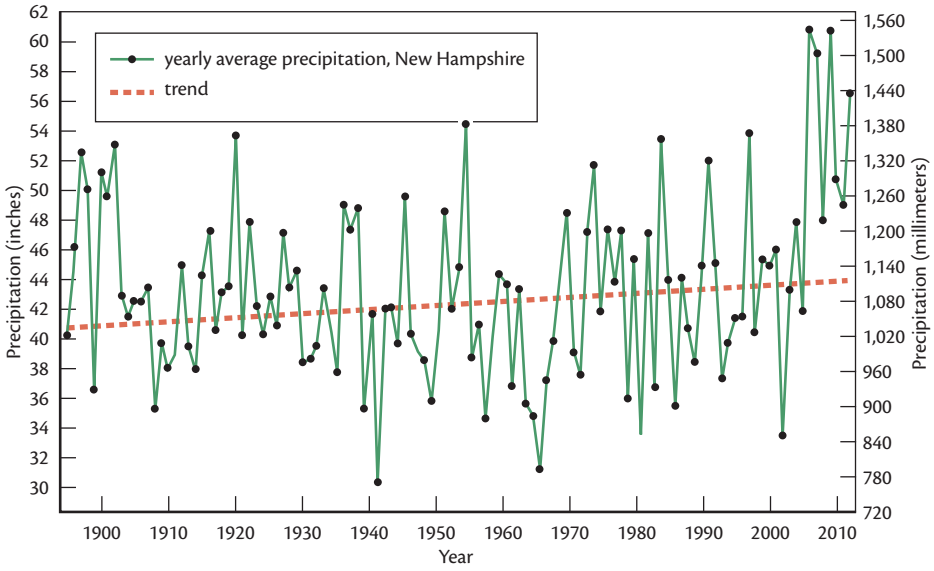

FIGURE 4.6
Graph showing annual precipitation between 1895 and 2011 in New Hampshire.

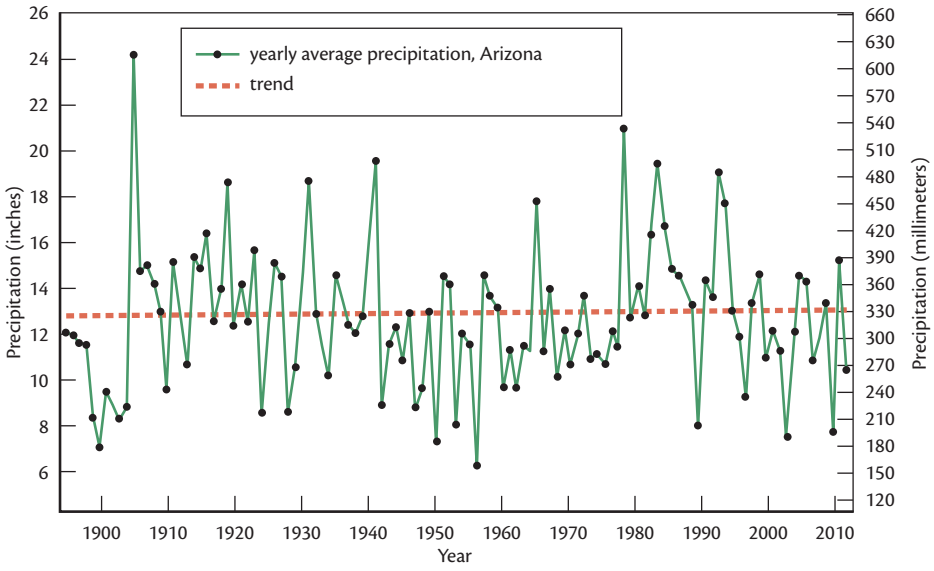

FIGURE 4.7:
Graph showing annual precipitation between 1895 and 2011 in Arizona.

Table 4.3: Average Annual Precipitation in New Hampshire Between 1976 and 2011[3]

YEAR	TOTAL PRECIPITATION (inches)	YEAR	TOTAL PRECIPITATION (inches)
2011	56.49	1993	39.69
2010	48.95	1992	37.28
2009	50.81	1991	44.47
2008	60.65	1990	52.01
2007	47.97	1989	43.99
2006	59.20	1988	38.32
2005	60.73	1987	40.55
2004	41.85	1986	44.08
2003	47.78	1985	35.41
2002	43.17	1984	44.78
2001	33.42	1983	53.38
2000	46.04	1982	36.78
1999	44.93	1981	47.08
1998	45.36	1980	33.58
1997	40.37	1979	45.30
1996	53.76	1978	36.03
1995	41.36	1977	47.24
1994	41.31	1976	43.67

Table 4.4: Total Annual Precipitation in Arizona Between 1976 and 2011[4]

YEAR	TOTAL PRECIPITATION (inches)	YEAR	TOTAL PRECIPITATION (inches)
2011	10.38	1993	17.60
2010	15.10	1992	19.07
2009	7.69	1991	13.48
2008	13.33	1990	14.28
2007	11.81	1989	7.90
2006	10.76	1988	13.20
2005	14.31	1987	13.90
2004	14.49	1986	14.46
2003	10.95	1985	14.76
2002	7.47	1984	16.45
2001	11.24	1983	19.41
2000	12.06	1982	16.77
1999	10.92	1981	12.79
1998	14.52	1980	14.14
1997	13.26	1979	12.68
1996	9.24	1978	20.90
1995	11.89	1977	11.34
1994	12.98	1976	12.14

5. Obtain data about the climate in your local area and your chosen destination. This should at a minimum include yearly temperature and precipitation data over at least a 30-year period. You may also find some other interesting climate data, such as days of sunshine, average snow measurements, and so on. Organize these data so that you can compare them to the graphs and tables for New Hampshire and Arizona. Study the data and answer the following questions:
   a. How do the trends in yearly temperature and precipitation for your local area and travel destination compare to the trends for New Hampshire and Arizona?
   b. Calculate the average temperature and the average precipitation over a 30-year period in your area and your travel destination. How do these averages compare to Arizona and New Hampshire?
   c. How will the climate make your experience at your destination different from home?

d. What do you know about the natural landscape in your travel destination? How is it different from your own, and how might the landscape reflect the climate?

Analysis

After you have obtained climate data for your local region and your travel destination, record your ideas about the following questions in your notebook. Be prepared to share your answers with the rest of the class.

1. Use specific examples from the graphs to support your answers to the following questions. If you have one year that is unusually warm or cold, wet or dry:
   a. Is that meaningful when you are trying to figure out the climate in a region?
   b. Does it tell you if climate is changing?
2. Trend curves are useful for detecting long-term changes in climate. How might the average annual temperature curves, which show year-to-year variations in weather, be useful to people living in states like New Hampshire and Arizona?
3. Based on your understanding from this activity, explain in your own words the difference between weather and climate.
4. Other than temperature and precipitation, what other weather conditions could be used to describe a region's climate?
5. What do you know about the natural landscape of Arizona and New Hampshire? Based on your knowledge about this, describe how they are different from each other and from your own region. Write your ideas about how these differences reflect the climates.

Prior to *Activity 1*—"Looking at Climate Data"

1. Arrange to project Figures 4.4–4.7 at the front of the classroom (see the Chapter 4 slide presentation in Teacher Resources). *Note: Teacher resources, including Powerpoint slides, are available in the full version of* EDC Earth Science.
2. Arrange for students to have access to the Internet to obtain climate data for their local area and travel destination (or, print up data for them to use). There are a number of possible sources of data on the Web (see suggested Web links for Chapter 4 or search for "world climate data").

ACTIVITY 1

Looking at Climate Data

This activity will help students understand how climate is measured and compared from one region to another.

Facilitating *Activity 1*—"Looking at Climate Data"

- Before students begin, you may want to discuss what the four graphs, Figures 4.4–4.7, show, review the nature of the two curves on each graph, and call their attention to the values on the axes of the graphs.
- Have students work with partners on this task. They will first answer questions about the climate data for Arizona and New Hampshire, and then will obtain and analyze data for their local area and chosen destination. Students can obtain these additional data from the Internet, or you may choose to print up data for them to use. As mentioned in Materials and Preparation, there are a number of possible Internet sources of climate data (search for "climate data" or "world climate data," and also see Teacher Resources for suggestions). Some websites are easier to use than others, so encourage students to share good sites when they find them. Remind students that they are looking for climate data (for periods of 30 years or more), not current weather information.
- You may want to project slides of the graphs as you discuss the Analysis questions as a class (*see* Chapter 4 slide deck in Teacher Resources).

Listening for Understanding

As students work, circulate around the room listening as they discuss the Analysis questions. Listen to make sure they are correctly interpreting the curves on each graph. It is particularly important for them to note and understand the variability on the actual temperature and precipitation curves relative to the trend curves.

Responses to *Analysis* for *Activity 1*—"Looking at Climate Data"

1. Use specific examples from the graphs to support your answers to the following questions. If you have one year that is unusually warm or cold, wet or dry:
   a. Is that meaningful when you are trying to figure out the climate in a region? *The weather conditions in any single year, particularly one that is unusual, are not very meaningful in determining climate. For example, Arizona had a year between 1900 and 1910 with much higher amounts of rainfall than are typical of that state.*
   b. Does it tell you if climate is changing? *Students should recognize that the yearly fluctuations may be misleading because the temperature or precipitation change from one year to the next may*

not be consistent with the overall climate trend. For example, the average temperature in Arizona in 1942 was approximately 61°F (16.1°C), and the following year the average temperature was only 58.5°F (14.7°C). However, the overall trend is toward an increasing average annual temperature.

2. Trend curves are useful for detecting long-term changes in climate. How might the average annual temperature curves, which show year-to-year variations in weather, be useful to people living in states like New Hampshire and Arizona? *The actual curves give a more realistic indication of how warm or how cold an area might be over a given year. This could be important when designing buildings or planning for energy needs.*
3. Based on your understanding from this activity, explain in your own words the difference between weather and climate. *Students should recognize that weather describes the conditions at a specific point in time, and climate describes the average weather conditions over a long time period (generally 30 years or more).*
4. Other than temperature and precipitation, what other weather conditions could be used to describe a region's climate? *Students may suggest that such parameters as humidity, wind, and atmospheric pressure, and such statistics as the number of sunny days or average snow depth could be used to describe a region's climate.*
5. What do you know about the natural landscape of Arizona and New Hampshire? Based on your knowledge about this, describe how they are different from each other and from your own region. Write your ideas about how these differences reflect the climates. *Answers will vary, depending on how familiar students are with the landscapes of Arizona and New Hampshire. They may know that much of Arizona has desert scrub and grassland vegetation characteristic of a hot, dry climate. Much of New Hampshire is currently forested with deciduous and coniferous trees, and reflects the cooler, wetter climate. In both states, however, elevation changes associated with mountain ranges bring other flora and fauna into certain areas. For example, coniferous forests are present at higher elevations in Arizona, and in fact, the San Francisco Peaks in the northern part of the state are more than 3,820 meters (12,600 feet) in elevation and have a climate and vegetation similar to Canada and Alaska. Mount Washington (elevation 1,917 meters or 6,288 feet) in New Hampshire has one of the harshest climates in the world and dwarf vegetation typical of alpine tundra.*

Teaching Strategies

You might want to show students some photographs of the landscapes of Arizona, New Hampshire, and their local area. Have them describe the differences and try to relate them to the climates.

