# Heating Things Up

## OVERVIEW —

Students graph average high monthly temperatures for different cities to learn how temperatures vary by location and by season.

**Grades:** 4 to 12

**Duration:** 15-45 minutes

## OBJECTIVE —

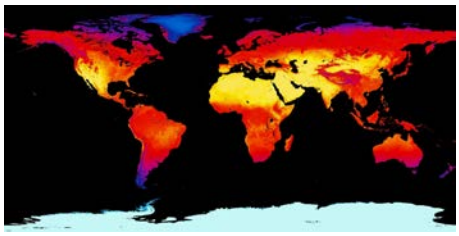
Students will:

- Observe and graph the temperatures of different cities at different months during a year.
- Describe how the average high temperatures change over the year as a function of their latitude.
- Analyze the patterns and describe how their understanding of the seasons relates to their observations.

## MATERIALS —

For the class:

- A map from NASA Earth Observations' Average Land Surface Temperature, projected or printed



*Map of average land surface temperature for June 2001*

For each student or pair of students:

- Student Worksheet
- Colored pencils or markers
- Either
  - copies of Heating Things Up maps for students OR
  - one or more laminated large world maps with cities from this activity and colored sticky dots

## ACTIVITY —

**Facilitator's Note:** This activity can be modified for different grade levels, length of time, and skills.

- Each student can graph temperature data for all of the cities, or students can work in small groups to graph all of the data, or each student can graph a separate city's data.
- Student can find the cities on a large map (which will take longer but can be used to integrate a social studies component), or use the attached simplified map to color-code the cities.
- Teachers can provide an example of a completed graph, or have the students create their first graph together to assist those students whose graphing skills are weak or rusty; this may also reduce the amount of time overall needed to create the graphs.
- Students can make and test predictions for the shapes of graphs for additional cities by gathering data for those cities online.

1. Project a map of the NASA Earth Observations' Average Land Surface Temperature, ideally for the current month. Invite the students to describe how the temperatures compare for different parts of the world.

2. Let the students know that they will be examining and analyzing temperature data for cities around the world. Invite the students to share their own knowledge and experiences but do not correct them or add to their ideas; they will be discovering the answers for themselves.
   - *Which months are the hottest where they live? Which months are the coolest?*
   - *Does everyone around the world have the same hot and cool months?*

3. Hand out copies of the student worksheet containing the temperature data and graph, or (if preferred) display the data with a projector and ask the students to use graph paper. Teachers may want to show a completed graph or remind the students how to create their graphs:
   - *What degrees are the temperatures in: Fahrenheit or Celsius*? (Celsius)
   - *Looking at the conversion graphic, is 30 degrees Celsius warm or cold?* (warm—about 85 F) *Is 10 degrees Celsius warm or cold?* (cold, about 50 F)
   - *What type of graph should the students create—a bar graph, line graph, or pie chart?* (A line graph—they are examining change over time.)
   - *Which line should the students place their first data point on?* (On the "January" line.)
   - *How many data points will they graph for each city?* (Four)

4. Assign students (individually or in pairs) to graph 3 cities each, dividing up the cities so that every city is being graphed. Ask the students to draw a line graph for their 3 cities on their worksheet, using different colored pencils or markers.

5. When the students are finished, have them gather into larger groups to share and discuss their results.
   - *Do they see any patterns to the shapes of their graphs?*
   - *How can they categorize the shapes of the graphs?*

6. Patterns students may observe: some cities have almost flat graphs, while have mountain shapes (with temperatures increasing then decreasing) or valley shapes (with temperatures decreasing then increasing).

7. Match each pattern to a separate color (such as flat = green, mountain shaped = red, valley shaped = blue), and have the students color-code the cities based on their temperature patterns, either using colored pencils and the *Heating Things Up* map or placing color-coded dots onto a map of the world, in the location of each of the cities.

8. Now invite them to discuss what they see.
   - *Is there a pattern to the colors of the dots?*

9. The students should observe that cities north of the equator increase in temperature from January to July and then decrease in temperature from August to December, while cities south of the equator decrease in temperature from January to July then increase from August to December, and that the cities near the equator have relatively flat graphs.

10. Possible extensions: students can predict the shapes for graphs for additional cities, then gather the data online and test their predictions.

## IN CONCLUSION —

*11.* Hold a class discussion, examining the patterns and identifying the seasons "summer" and "winter" for those cities with significant seasons (those not at or very close to the equator). If students are more advanced, they may notice that cities closer to the poles have greater changes in temperatures and steeper slopes for their graphs. Invite the students to speculate why cities at different latitudes have different patterns or seasons.

## BACKGROUND INFORMATION

A common false assumption is that the Earth is hotter in the summer because it is closer to the Sun. This activity challenges this misconception by demonstrating that the hemispheres have different seasons. In contrast to the northern hemisphere, the southern hemisphere has summer in December-February, and winter in June-August, and the equatorial regions have tropical weather year-round.

Some students at the middle or high school level may be puzzled by the temperature changes for Nairobi, which is on the equator. Nairobi and other cities near the equator often have rainy seasons and dry seasons. Moist air traps heat more effectively at night, preventing cities from cooling as effectively, so temperatures can be cooler during the dry season in Nairobi.

## RESOURCES

Additional information about temperatures and seasons

- NASA Now: Reasons for the Seasons is a YouTube video about seasons on Earth and other planets.
- My NASA Data has global data on temperatures, solar radiation, and other variables that can be used in designing follow-up activities and extensions.
- NASA Earth Observations has global maps of average land surface temperatures and many other variables for different dates.
- NASA SciJinks has information and games about weather.
- NASA Wavelength has a variety of activities and articles about seasons, searchable by topic, grade level, resource type, and more.

## CORRELATION TO STANDARDS

### Next Generation Science Standards

**Assessment Standard:**

- 5-ESS1-2: Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.

**Disciplinary Core Ideas**

- ESS1.B: The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year.

**Science and Engineering Practices**

- Asking Questions and Defining Problems: Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information.
- Analyzing and Interpreting Data: Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships.
- Analyzing and Interpreting Data: Represent data in graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships.
- Analyzing and Interpreting Data: Analyze and interpret data to provide evidence for phenomena.
- Using Mathematics and Computational Thinking: Describe, measure, estimate, and/or graph quantities (e.g., area, volume, weight, time) to address scientific and engineering questions and problems.

**Crosscutting Concepts**

- Patterns: students identify patterns in rates of change and other numerical relationships that provide information about natural and human designed systems. They use patterns to identify cause and effect relationships, and use graphs and charts to identify patterns in data.
- Patterns: Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena.

# Heating Things Up: Student Worksheet

| Average Monthly High Temperatures (Celsius) | | | | |
|---|---|---|---|---|
| ***City*** | ***Jan.*** | ***Apr.*** | ***July*** | ***Oct.*** |
| Anchorage (Alaska) | -4 | 6 | 18 | 5 |
| Buenos Aires (Argentina) | 29 | 22 | 15 | 22 |
| Cape Town (South Africa) | 28 | 23 | 18 | 21 |
| Caracas (Venezuela) | 25 | 27 | 26 | 27 |
| Houston (Texas) | 15 | 25 | 33 | 26 |
| London (United Kingdom) | 9 | 15 | 23 | 16 |
| Mexico City (Mexico) | 21 | 25 | 22 | 23 |
| Montreal (Canada) | -4 | 11 | 26 | 14 |
| Nairobi (Kenya) | 26 | 25 | 22 | 27 |
| Rio de Janeiro (Brazil) | 30 | 28 | 25 | 26 |
| Singapore (Singapore) | 30 | 31 | 31 | 31 |
| Stockholm (Sweden) | -1 | 9 | 22 | 10 |
| Sydney (Australia) | 26 | 23 | 17 | 22 |
| Tokyo (Japan) | 8 | 17 | 28 | 20 |

*Fahrenheit*

0 10 20 30 40 50 60 70 80 90 100 110 120 130 140

-20 -10 0 10 20 30 40 50 60

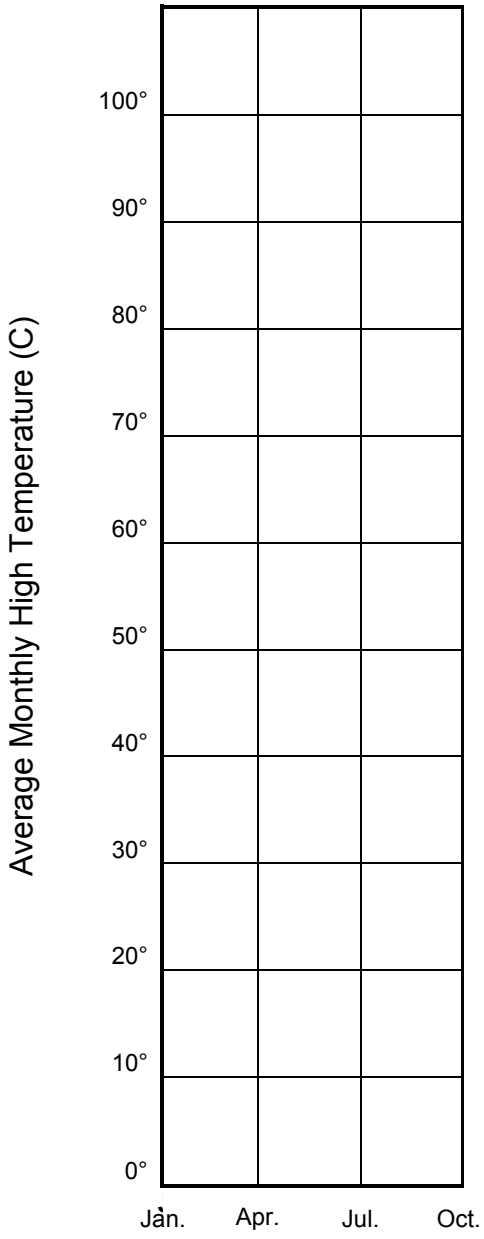
*Celsius*

**Color code your graphs by city:**

City #1: _____

City #2: _____

City #3: _____



# Heating Things Up: Map