The Sun's Effect on Climate
Lesson 5a: Latitude and Patterns in Temperature

Grade 6	**Length of lesson:** 45 minutes	**Placement of lesson in unit:** 5a of 7 two-part lessons on the Sun's effect on climate
Unit central question: Why are some places on Earth hotter than others at different times of the year?		**Lesson focus question:** Why do some places at the same latitude have different temperature patterns?
Main learning goal: While the curved surface of Earth, its consistent tilt, and its orbital path around the Sun are key factors that produce climate variations at different latitudes, other factors, such as elevation and proximity to large bodies of water, influence climate and temperature patterns as well.		
Science content storyline: The curved surface of Earth, its consistent tilt, and its orbit around the Sun are key factors that produce climate variations at different latitudes. But other factors influence climate and cause temperature variations beyond the latitude of a location. Elevation and proximity to large bodies of water, for example, can cause variations in temperature patterns at the same latitude. Proximity to large bodies of water, such as oceans, influences regional climates and helps maintain steady temperatures throughout the year. Elevation also influences regional climates, with higher elevations generally experiencing cooler temperatures than lower elevations.		
Ideal student response to the focus question: The angle of sunlight influences the amount of heating on Earth's surface. Places closer to the equator that receive more direct sunlight (or solar radiation) tend to have higher average temperatures than places closer to the poles that receive less direct sunlight. But sometimes places at the same latitude can have very different climates, or temperature patterns. Other things can influence temperature besides the angle of sunlight and Earth's tilt. Higher elevations tend to have cooler temperatures in general, and places that are closer to large bodies of water, like oceans, usually have more steady temperatures throughout the year.		

Preparation

Materials Needed
- Science notebooks
- Chart paper and markers
- Colored pencils (enough for each student to have three colors) (If possible, each student should use the same three colors.)

Student Handouts and Teacher Masters
- 1.1 Map of Average Temperatures in the United States, December–February (Teacher Master from lesson 1a) (for display; see Ahead of Time)
- 5.1 Map of Average Temperatures in the United States, June–August (Teacher Master) (for display; see Ahead of Time)
- 5.2 Investigating Temperatures at the Same Latitude (1 per student)

Ahead of Time
- Review section 8 (Other Factors That Influence Temperature) in the SEC content background document.
- Prepare handouts 1.1 and 5.1 for display on a document reader or Smart Board.
- *ELL support:* Identify words from Tiers 2 and 3 in the lesson to review with students, as well as scientific terms that may be new to them. These terms may be problematic for students: *the curvature of Earth's surface*, *climate*, *proximity*, *regional climates*, *steady temperatures*, *elevation*, *higher elevations*, *tend*, *average monthly temperatures*, *plot*, *line graph*.

Lesson 5a General Outline

Time	Phase of Lesson	How the Science Content Storyline Develops
5 min	**Link to previous lessons:** Students review the primary reasons for temperature variations on Earth from previous lessons and discuss their current ideas for answering the unit central question.	• The curved surface of Earth, its consistent tilt, and its orbit around the Sun are key factors that produce climate variations at different latitudes.
5 min	**Lesson focus question:** The teacher introduces the focus question, *Why do some places at the same latitude have different temperature patterns?* Students share examples of places where the climate was different from what they expected.	
5 min	**Setup for activity:** Students identify places in the United States that don't follow the typical latitudinal pattern for average temperatures.	• Other factors beyond latitude influence the climate of a location.
20 min	**Activity:** Students work in small groups to investigate data showing average monthly temperatures for three US cities located at approximately the same latitude. They plot this data on a line graph and look for patterns as they compare the temperatures of these cities.	• There are regional differences in the temperature patterns of three US cities located at the same latitude across the country.
5 min	**Follow-up to activity:** Groups share the temperature patterns they observed in their line-graph data.	• There are regional differences in the temperature patterns of three US cities located at the same latitude across the country. Therefore, something other than latitude must influence average temperatures in certain locations.
4 min	**Synthesize/summarize today's lesson:** Students write a preliminary answer to the focus question using their line-graph data.	• Proximity to large bodies of water, such as oceans, influences regional climates and helps maintain steady temperatures throughout the year. Elevation also influences regional climates, with higher elevations generally experiencing cooler temperatures than lower elevations.
1 min	**Link to next lesson:** The teacher announces that in the next lesson, students will use a physical map showing the regional geography of the three US cities to help them analyze their temperature data.	

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5 min	**Link to Previous Lessons** **Synopsis:** Students review the primary reasons for temperature variations on Earth from previous lessons and discuss their current ideas for answering the unit central question. **Main science idea(s):** • The curved surface of Earth, its consistent tilt, and its orbit around the Sun are key factors that produce climate variations at different latitudes.	Link science ideas to other science ideas.	**Show slides 1 and 2.** In previous lessons, we discovered some important factors that help us explain why there are different temperatures around the globe at different times of the year. **Small-group discussion:** Think about these science ideas as you gather in your small groups from last time and discuss the *best ideas* you've come up with so far for answering our unit central question, *Why are some places on Earth hotter than others at different times of the year?* Be prepared to share your ideas and evidence with the class. **ELL support:** Give ELL students time to review the ideas they've written in their science notebooks. **NOTE TO TEACHER:** *Allow 2 or 3 minutes for groups to discuss their ideas for answering the unit central question. As you circulate from group to group, listen carefully to students' conversations. Do they mention Earth's tilt? Are they able to describe the angle of incoming sunlight and how it varies at different latitudes? Do they mention Earth's orbit around the Sun? Keep track of misconceptions or incomplete explanations so that you can challenge student thinking during today's lesson.* **Whole-class share-out:** What ideas did your group come up with to explain why some places on Earth are hotter than others at different times of the year? Share only your *best* ideas and		

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			evidence.	Some places are hotter near the equator than at the poles. It's because of Earth's tilt. It's because of the angle of sunlight. As Earth goes around the Sun, different places have different seasons.	Why is that? In what ways does Earth's tilt affect temperatures? How does the angle of sunlight affect temperatures? Say more about Earth's position during its orbit around the Sun. Why does that make a difference?
5 min	**Lesson Focus Question** **Synopsis:** The teacher introduces the focus question, *Why do some places at the same latitude have different temperature patterns?* Students share examples of places where the climate was different from what they expected.	Set the purpose with a <u>focus question</u> or goal statement.	The angle of sunlight hitting Earth at different latitudes explains why we have temperature variations on Earth. But throughout this series of lessons, we've discovered that other factors besides the angle of sunlight and latitude can influence temperature patterns in different locations. **Show slide 3.** Today we'll explore other factors besides the angle of sunlight that can influence climate and temperature patterns on Earth. What we discover will help us answer the focus question for this lesson, *Why do some places at the same latitude have different temperature patterns?*		

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			Write this question in your science notebooks and draw a box around it. **Show slide 4.** **Small-group discussion:** What are some other factors that might explain why some places at the same latitude have different temperature patterns? Discuss this question in your small groups and write your ideas in your science notebooks. Be ready to share with the class. **ELL support:** To help ELL students visualize possible factors affecting temperature patterns at the same latitude, you may want to display a large map of the United States that shows latitude lines and major cities. **NOTE TO TEACHER:** *Give groups 2–3 minutes to talk about their ideas. If students bring up factors that have a short-term impact on temperatures, such as a cloudy day, rain, or wind, emphasize that you're investigating* ***long-term temperature patterns*** *as opposed to weather that happens on a day-to-day basis.* **Whole-class discussion:** Before you share the ideas you came up with in your groups, let's talk about examples of different temperature patterns at the same latitude. For instance, are there places that tend to be hotter or cooler than other places in our region of the country?	I went skiing once, and there was snow in the mountains, but there wasn't any snow in the surrounding area.	Why do you think

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					there might have been snow in the mountains but none in the surrounding area?
				The mountains get more snow, so it's colder there in the winter. It's cooler in the summer, too. It's hotter in the valley than at the beach.	Cooler than where? At what time of year? Is it also hotter in the valley in the winter?
			Your examples give us some clues about other factors that can influence temperatures on Earth. What do you think those factors are? What ideas did your group come up with for answering our focus question?		
5 min	**Setup for Activity** **Synopsis:** Students identify places in the United States that don't follow the typical latitudinal pattern for average temperatures. **Main science idea(s):** • Other factors beyond latitude influence the climate of a location.	Select content representations and models matched to the learning goal and engage students in their use. Ask questions to elicit student ideas and predictions.	**Show slides 5 and 6.** To prepare for today's activity, let's look at two temperature maps of the United States and see if we can find examples of various places at the same latitude that have different average temperatures. **Show slide 7.** **Turn and Talk:** Work with a partner to identify any areas on each map where you think temperature patterns might be different from other areas *at the same latitude*. Notice whether these patterns show up in the winter and the summer. Record these locations in your science		

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			notebooks and be prepared to explain your decisions. **NOTE TO TEACHER:** *Display on a document reader or Smart Board handout 1.1 (Map of Average Temperatures in the United States, December–February) and handout 5.1 (Map of Average Temperatures in the United States, June–August). Allow time for students to view each map and note areas where temperature patterns might be different from other areas at the same latitude (also called* latitudinal banding*).* **Whole-class discussion:** Where did you observe areas on each map that might have different temperature patterns even though they're at the same latitude? **NOTE TO TEACHER:** *If students are having difficulty coming up with ideas, use some questions such as, "If we drove straight east from our town for 3 hours [or 10 hours], what would the temperatures be like when we arrived in that new place? Would they be the same or different from temperatures in our town?"* Do these temperature patterns show up in both	In the East, it's warmer in the south and cooler in the north, but in California, it doesn't look that way. There's a strip along the coast of California that's cooler than farther inside. There are cooler circle areas in the middle of the US. I think those areas are in the mountains.	Can you say more about that? What different pattern do you see? What do those "circle areas" mean? Where are they located?

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			the winter and the summer?		
20 min	**Activity** **Synopsis:** Students work in small groups to investigate data showing average monthly temperatures for three US cities located at approximately the same latitude. They plot this data on a line graph and look for patterns as they compare the temperatures of these cities. **Main science idea(s):** • There are regional differences in the temperature patterns of three US cities located at the same latitude across the country.	Make explicit links between science ideas and activities **during** the activity.	Are you ready to find out why some places at the same latitude have different temperature patterns? **NOTE TO TEACHER:** *Divide the class into groups of four or five students and distribute handout 5.2 (Investigating Temperatures at the Same Latitude). Orient students to the activity and review the instructions on the handout. Emphasize that if they need help constructing their line graphs, they can refer to the instructions on page 2 of the handout or ask for assistance. Make sure each student has three different-colored pencils to represent each city on the graph. If all students have the same three colors, assign the same color to each city.* *Ask students which data they want to plot on the* x*-axis and on the* y*-axis. Remind students to use the blank graph on the handout so that the scale of both axes will be the same from one point to the next. With this data set, students can label the lowest temperature (39 °F) and highest temperature (87 °F) on the graph and label other temperatures in five-degree increments.* **Show slide 8.** For this activity, you'll work in small groups to investigate temperature patterns in three US cities that are located at approximately the same latitude. The data table on your handout shows the average monthly temperatures for each city throughout the year. Using this data, you'll create a line graph and then look for temperature patterns. On the back of the		

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		Select content representations and models matched to the learning goal and engage students in their use.	handout are instructions for making a line graph, and I'll be available to help as well. After completing your line graphs, talk in your groups about any patterns you notice, including the similarities and differences you observe when you compare the temperatures of these cities. Record your observations in the box on page 2 of the handout. If these cities are at the same latitude, do you think the angle of sunlight hitting Earth at those locations would be the same or different? **ELL support:** If ELL students are unsure whether the angle of sunlight is the same or different, use the flashlight and globe model from earlier lessons to help them visualize this more clearly. **NOTE TO TEACHER:** *Make sure students understand that an average monthly temperature is the average across all daily temperatures for a month.* *While groups are working on their line graphs and discussing their observations, circulate around the room, providing assistance as needed and listening to students' conversations.*	The angle of sunlight would be the same at the same latitude.	
5 min	**Follow-Up to Activity** **Synopsis:** Groups share the temperature patterns they observed in their line-graph data. **Main science idea(s):**	Engage students in analyzing and interpreting data and observations.	**Show slide 9.** Now that you've finished your line graphs, let's talk about any patterns you noticed in the temperature data. As you share your group's observations, I'll write these patterns on chart paper.		

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	• There are regional differences in the temperature patterns of three US cities located at the same latitude across the country. Therefore, something other than latitude must influence average temperatures in certain locations.		So what temperature patterns did you notice in the data for the three cities? **NOTE TO TEACHER:** *Record on chart paper (or a whiteboard) the patterns students noticed in the temperature data. Label the chart "Temperature Patterns for Three Cities."*	San Francisco's temperatures stay pretty flat, but Colorado Springs and St. Louis have a big curve. *Flat* means the temperatures stay pretty much the same all year. The *big curve* means that temperatures start out cold in January, get hotter in the summer, and then get colder again in the fall. There's only 13 degrees difference in temperature between the hottest and coldest months in San Francisco, but temperatures vary by more than 40 degrees in the other two cities from the highest to the lowest temperatures. San Francisco is warmest in the fall,	What do you mean by "flat" and "a big curve"? Does anyone have anything to add? Do you agree or disagree with this observation? Tell us how you discovered that pattern.

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				while the other two cities are warmest in the summer. Compared to the other two cities, it never gets very cold in San Francisco.	Did another group notice anything else about the seasons in these three cities?
4 min	**Synthesize/Summarize Today's Lesson** **Synopsis:** Students write a preliminary answer to the focus question using their line-graph data. **Main science idea(s):** • Proximity to large bodies of water, such as oceans, influences regional climates and helps maintain steady temperatures throughout the year. Elevation also influences regional climates, with higher elevations generally experiencing cooler temperatures than lower elevations.	Highlight key science ideas and focus question throughout. Engage students in making connections by synthesizing and summarizing key science ideas.	**Show slide 10.** Our focus question for this lesson is *Why do some places at the same latitude have different temperature patterns?* Think about the temperature patterns we identified in the line-graph data and write a possible answer to this question in your science notebooks. **NOTE TO TEACHER:** *Give students a couple of minutes to reflect on today's activity and write down their initial ideas for answering the focus question.* **Whole-class discussion:** So what did you learn from today's activity that might help us answer our focus question? That's an important observation, but it doesn't exactly tell us *why* these different temperature	We learned that some places have different temperature patterns even though they're at the same latitude.	

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			patterns happen, does it? We need more information to figure this out.		
1 min	**Link to Next Lesson** **Synopsis:** The teacher announces that in the next lesson, students will use a physical map showing the regional geography of the three US cities to help them analyze their temperature data.	Make explicit links between science ideas and activities.	**Show slide 11.** In the next lesson, we'll use a new content representation to help us make sense of different temperature patterns at the same latitude.		