The Sun's Effect on Climate
Lesson 5b: More than Latitude

Grade 6	**Length of lesson:** 35 minutes	**Placement of lesson in unit:** 5b 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 **Student Handouts** • 5.2 Investigating Temperatures at the Same Latitude (from lesson 5a) • 5.3 Map of Three Cities in the United States (1 per pair of students)	**Ahead of Time** • Review section 8 (Other Factors That Influence Temperature) in the SEC content background document.

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Lesson 5b General Outline

Time	Phase of Lesson	How the Science Content Storyline Develops
5 min	**Link to previous lesson:** Students share their preliminary answers to the focus question from the previous lesson.	• 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.
3 min	**Lesson focus question:** The teacher reviews the focus question, *Why do some places at the same latitude have different temperature patterns?*	
5 min	**Setup for activity:** Students review their line-graph data from the previous lesson and the temperature patterns of three US cities at the same latitude. The teacher introduces a new content representation to help students make sense of the data.	• There are regional differences in the temperature patterns of three US cities located at the same latitude across the country.
10 min	**Activity:** Students examine a physical map showing the regional geography of three US cities. Then they use evidence from the map to determine the likely factors that influence the temperatures of each city.	• Proximity to large bodies of water, such as oceans, influences regional climates and help maintain steady temperatures throughout the year. Elevation also influences regional climates, with higher elevations generally experiencing cooler temperatures than lower elevations.
6 min	**Follow-up to activity:** Students review key science ideas about Earth's tilt and the angle of sunlight and consider how regional geography, such as elevation and proximity to large bodies of water, can also influence temperature patterns.	• Temperatures on Earth vary according to latitude. The curved surface of Earth, its consistent tilt, and its orbit around the Sun are key factors that produce climate variations at different latitudes. The angle of sunlight hitting Earth's surface causes variations in the amount (intensity) of solar radiation in different locations, and Earth's consistent tilt produces opposite seasons in the Northern and Southern Hemispheres. But other factors, such as elevation and proximity to large bodies of water, also influence temperature patterns on Earth.
5 min	**Synthesize/summarize today's lesson:** Students revisit the unit central question and use what they've learned so far to propose an explanation.	• Many factors influence temperature patterns on Earth. The curved surface of Earth, its consistent tilt, its orbit around the Sun, the angle at which sunlight (solar radiation) strikes Earth's surface at any given location, elevation, and proximity to large bodies of water are all factors that explain why some places are hotter than others at different times of the year.
1 min	**Link to next lesson:** The teacher previews the next lesson, in which students investigate how the proximity of an ocean or another large body of water affects temperature patterns on land.	

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5 min	**Link to Previous Lesson** **Synopsis:** Students share their preliminary answers to the focus question from the previous lesson. **Main science idea(s):** • 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.	Make explicit links between science ideas and activities.	**Show slides 1 and 2.** Last time we investigated temperature patterns for three US cities located at the same latitude. Then based on your line-graph data, you wrote a possible answer to the focus question, *Why do some places at the same latitude have different temperature patterns?* Let's hear some of your ideas. Make sure to support your explanations with observations and evidence from your line graphs on the handout. **NOTE TO TEACHER:** *Have students locate handout 5.2 (Investigating Temperatures at the Same Latitude) from the previous lesson. Keep this discussion brief. The purpose is to make student thinking visible at the beginning of the lesson.*	The temperatures in San Francisco don't change too much from one month to the next. I think it's because the city is in a bay. I know Colorado has mountains, but I don't know whether Colorado Springs is in the mountains. If it is, that could have something to do with the temperatures. I know St. Louis is by the Mississippi River. Maybe the river affects	Does anyone want to add to that idea? What difference would it make if Colorado Springs were in the mountains?

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				the temperatures somehow.	Say more about being near a river might affect temperatures.
3 min	**Lesson Focus Question** **Synopsis:** The teacher reviews the focus question, *Why do some places at the same latitude have different temperature patterns?*	Set the purpose with a focus question or goal statement.	**Show slide 3.** Today we'll continue investigating our focus question from last time: *Why do some places at the same latitude have different temperature patterns?* We already know that places at the same latitude can have different temperature patterns, but we don't really understand why this happens. That's what we'll explore in this lesson.		
5 min	**Setup for Activity** **Synopsis:** Students review their line-graph data from the previous lesson and the temperature patterns of three US cities at the same latitude. The teacher introduces a new content representation to help students make sense of the data. **Main science idea(s):** • There are regional differences in the temperature patterns of	Make explicit links between science ideas and activities **before** the activity.	**Show slide 4.** **NOTE TO TEACHER:** *Students will need handout 5.2 (Investigating Temperatures at the Same Latitude) for this discussion as well.* Last time, you created a line graph showing temperature patterns for San Francisco, California; Colorado Springs, Colorado; and St. Louis, Missouri. Each line represented the average monthly temperatures of one city over the course of a year. All three of these cities are located at the same latitude. The lines on our graphs helped us compare the temperature patterns of these cities through all four seasons—winter, spring, summer, and fall.		

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	three US cities located at the same latitude across the country.	Link science ideas to other science ideas. Ask questions to elicit student ideas and predictions.	Look at the different temperature patterns you recorded on page 2 of handout 5.2. These temperature patterns weren't exactly what we expected to see, were they? Let's talk for a moment about the temperature patterns we *would* expect to see in all three locations. At a latitude of approximately 38° N, would the Sun's incoming rays be hitting these cities straight on or at an angle? What is your evidence? Now think about the diagrams we've seen that show the Sun's incoming energy hitting a tilted Earth at an angle. Based on those diagrams, what temperature patterns would you expect to see in all three cities since they're located at about the same latitude? Why? That's right. The temperatures during the same months at the same latitude should be about the same for all three cities because they should be receiving the same amount of solar radiation. Something else must be going on!	No! The Sun's rays would hit at an angle. My evidence is the rays of sunlight we counted in lesson 4. The temperatures for all three cities should be about the same because they're at the same latitude.	
10 min	**Activity**		**Show slide 5.**		

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	Synopsis: Students examine a physical map showing the regional geography of three US cities. Then they use evidence from the map to determine the likely factors that influence the temperatures of each city. **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.	Select content representations and models matched to the learning goal and engage students in their use. Engage students in constructing explanations and arguments.	Today, you and a partner will look at another content representation, a physical map showing the geography of the United States. **NOTE TO TEACHER:** *Distribute handout 5.3 (Map of Three Cities in the United States) to each pair of students.* **Show slide 6.** **Turn and Talk:** As you and your partner study this physical map, consider these questions: 1. What do you observe about the location of each city on the map? 2. What geographical or physical features do you notice that might account for the different temperature patterns of these cities? **NOTE TO TEACHER:** *Give students several minutes to study the map and discuss their observations with their partners.* **Whole-class discussion:** What did you notice about the physical geography of the three cities that might account for the different temperature patterns we noticed on our line graphs? What did you observe about where these places are located? Use evidence from the map to support your answers, and I'll chart your ideas. **NOTE TO TEACHER:** *Students should notice*	The ocean. San Francisco is close to the Pacific Ocean, so maybe the ocean has something to do with it.	Use a complete sentence, please.

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			that Colorado Springs is at a higher elevation, near the Rocky Mountains, and that San Francisco is on the coast near the Pacific Ocean. St. Louis is located inland, with no mountains or large body of water nearby.	I think it's because San Francisco is in the West, and the West is hotter than the East.	What do you mean by "it"? Can anyone add to that idea? Do you have any evidence to support that idea?
			Show slide 7. Here's what we've observed so far: • San Francisco is close to the Pacific Ocean. • Colorado Springs is near the Rocky Mountains. • St. Louis is in the center of the United States and isn't near the mountains or a large body of water like an ocean.	Like in movies about the West, it's always hot—I never see snow.	What about evidence from our data?
		Ask questions to elicit student ideas and predictions.	So how do you think the location of each city might influence temperature patterns? First, let's talk about San Francisco. How might being near the Pacific Ocean influence temperature patterns in that city?	The ocean makes the temperatures not so different between summer and winter. The line graph is my	What's your evidence?

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				evidence. The line for San Francisco is almost flat, and temperatures hardly change from one month to the next.	
			How do you think elevation might affect temperatures in a place like Colorado Springs?	Colorado Springs is higher in elevation and right next to the Rocky Mountains, so maybe being near the mountains changes temperatures.	Say more about why you think mountains can change temperatures.
				It's cooler at higher elevations.	What's your evidence?
				The temperatures in Colorado Springs are usually cooler than those in cities at lower elevations, like St. Louis and San Francisco. San Francisco stays cooler in the summer, but otherwise, Colorado Springs stays cooler, especially cooler than St. Louis.	

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			What about temperatures in a place like St. Louis?	St. Louis isn't close to an ocean or mountains.	Tell us about the temperatures in St. Louis.
				The temperatures are hot in the summer and cold in the winter, which seems right for this latitude.	
			Show slide 8.		
		Summarize key science ideas.	Let's review some of the key science ideas we've learned about in this unit so far: • Not all places at the same latitude have the same average temperatures. • Latitude, while important, isn't the only factor that determines the temperatures at a specific location on Earth. • Other factors that influence climate and temperature patterns are elevation, or how high a location is above sea level, and being near a large body of water like an ocean. So now we have some evidence that latitude isn't the only factor that influences temperature patterns. Other factors like elevation and being close to a large body of water affect temperatures in different places, but we still don't know *how* this happens, do we? In the next two lessons, we'll gather more		

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			information that will help us figure this out.		
6 min	**Follow-Up to Activity** **Synopsis:** Students review key science ideas about Earth's tilt and the angle of sunlight and consider how regional geography, such as elevation and proximity to large bodies of water, can also influence temperature patterns. **Main science idea(s):** • Temperatures on Earth vary according to latitude. The curved surface of Earth, its consistent tilt, and its orbit around the Sun are key factors that produce climate variations at different latitudes. The angle of sunlight hitting Earth's surface causes variations in the amount (intensity) of solar radiation in different locations, and Earth's consistent tilt produces opposite seasons in the Northern and Southern	Link science ideas to other science ideas. Highlight key science ideas	**Show slide 9.** In this unit on climate, we've learned some important science ideas that help explain the variations in temperature patterns around the world: • Earth's tilt and the angle of sunlight cause solar radiation to hit certain places on Earth more directly and other places less directly. When sunlight hits Earth's curved surface more directly, solar radiation is more concentrated. When it hits the surface less directly, solar radiation is more spread out and less intense. • Latitudes closer to the poles generally have cooler temperatures than latitudes closer to the equator. • As Earth orbits the Sun, the most direct angles of sunlight reach different parts of Earth at different times of the year. This causes opposite seasons in the Northern and Southern Hemispheres. Sunlight is more direct in the Northern Hemisphere between June and August and in the Southern Hemisphere between December and February. **Show slide 10.** How can these science ideas help us answer today's focus question, *Why do some places at*		

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	Hemispheres. But other factors, such as elevation and proximity to large bodies of water, also influence temperature patterns on Earth.	and focus question throughout.	*the same latitude have different temperature patterns?* **Small-group discussion (2 min):** Discuss this in your small groups and then write your *best answer* to the focus question in your science notebooks. Be ready to share your ideas with the class. **Whole-class discussion:** What do you think? Why do some places at the same latitude have different temperature patterns?	If a place is at a higher elevation, it has cooler temperatures. Or if a place is by the ocean, the temperatures stay the same all year round.	What do you mean by "stay the same"? Are you saying the temperature never changes?
5 min	**Synthesize/Summarize Today's Lesson** **Synopsis:** Students revisit the unit central question and use what they've learned so far to propose an explanation. **Main science idea(s):** • Many factors influence	Engage students in making connections by synthesizing and summarizing key science ideas.	**Show slide 11.** Based on everything you've learned so far in this unit about the Sun's effect on climate, how would you answer our unit central question now: *Why are some places on Earth hotter than others at different times of year?* **Small-group discussion:** Discuss this question in your small groups and come up with your *best answer* using science ideas from all of our		

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	temperature patterns on Earth. The curved surface of Earth, its consistent tilt, its orbit around the Sun, the angle at which sunlight (solar radiation) strikes Earth's surface at any given location, elevation, and proximity to large bodies of water are all factors that explain why some places are hotter than others at different times of the year.		lessons. You can look through your science notebooks and handouts to refresh your memories as needed. Be ready to share your group's answer with the class. **ELL support:** Posting key terms on chart paper or on the board (i.e., public and visible) will help scaffold this discussion. **NOTE TO TEACHER:** *To find out what students really understand about the science ideas, you may want to avoid prompting them to use specific vocabulary or allowing them to look at charts of key ideas from previous lessons. However, if students are struggling, such resources may be needed to clarify their thinking and correct misconceptions.* ***Embedded Assessment Task*** *Are students correctly linking Earth's tilt and orbit, the intensity of sunlight at different latitudes, and regional geography to variations in temperature patterns? An ideal student response will focus on the angle of incoming energy from the Sun causing latitudinal differences in various locations on Earth, but it should also include regional variations in these patterns influenced by proximity to large bodies of water and elevation.* **Whole-class discussion:** What ideas did your group come up with to answer our unit central question? Who would like to share your best answer?		

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			NOTE TO TEACHER: *Keep track of student ideas on chart paper so they can refer to them during the next lesson*.		
1 min	**Link to Next Lesson** **Synopsis:** The teacher previews the next lesson, in which students investigate how the proximity of an ocean or another large body of water affects temperature patterns on land.	Link science ideas to other science ideas.	**Show slide 12.** Next time we'll see if we can figure out how oceans or other large bodies of water affect temperatures in nearby locations.		