The Sun's Effect on Climate
Lesson 6b: Factors That Affect Climate

Grade 6	**Length of lesson:** 45 minutes	**Placement of lesson in unit:** 6b 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:** How does being near the ocean or at a higher elevation affect air temperature?
Main learning goal: Water and land absorb and reflect (release) the Sun's incoming energy at differing rates. These variations in heating and cooling rates impact regional climates by affecting average air temperatures. Elevation is another factor that affects average air temperatures and regional climates.		
Science content storyline: Other factors influence regional climates beyond latitude, the curved surface of Earth, its consistent tilt, and its orbital path around the Sun. Temperature data show that locations near the ocean experience less temperature variation throughout the year than locations far from large bodies of water, and locations at higher elevations experience cooler average temperatures than locations at lower elevations. What accounts for these variations? Oceans and large bodies of water absorb and reflect (release) solar energy at slower rates than land. This causes air temperatures near large bodies of water to heat and cool more slowly throughout the year. Conversely, air temperatures above land heat and cool at faster rates than water. As a result, interior regions of a continent experience more extreme temperature variations throughout the year. Elevation is another factor that can lead to variations in temperature patterns. Higher elevations generally experience cooler temperatures than lower elevations because the air is less dense and absorbs less heat.		
Ideal student response to the focus question: Water absorbs and releases heat more slowly than land. This affects the air temperatures above land and water. Air temperatures above water are steadier throughout the year, while air temperatures above land have bigger temperature changes. So places near oceans or large bodies of water, like San Francisco, have more steady temperatures all year long, but temperatures in places like St. Louis and Colorado Springs have bigger temperature changes. This helps explain differences in regional climates. Elevation also affects temperatures. It's cooler at higher elevations because the air is less dense and can't hold as much heat.		

Preparation

Materials Needed • Science notebooks • Chart paper and markers • Colored pencils **Student Handouts** • 5.2 Investigating Temperatures at the Same Latitude (from lesson 5a) • 6.1 Uneven Heating (Part 1: Investigation Soil and Water Temperatures (from lesson 6a) • 6.1 Uneven Heating (Part 2: Investigating Elevation) (1 per student) • 6.3 Climb to Cold (1 per student)	**Ahead of Time** • Review section 8 (Other Factors That Influence Temperature) in the SEC content background document.

Lesson 6b General Outline

Time	Phase of Lesson	How the Science Content Storyline Develops
5 min	**Link to previous lesson:** Students share the sentences they completed in the previous lesson regarding which temperature patterns for the three cities are consistent with proximity to a large body of water.	• Factors other than latitude, such as elevation and proximity to large bodies of water, influence regional climates.
3 min	**Lesson focus question:** The teacher introduces the focus question, *How does being near the ocean or at a higher elevation affect air temperature?* and notes the addition of elevation as a factor influencing temperature patterns.	• Factors other than latitude, such as elevation and proximity to large bodies of water, influence temperature patterns and regional climates.
5 min	**Setup for activity:** The teacher introduces the activity, explaining that students will create an elevation profile of Mount Everest and plot temperature data on a line graph.	• The elevation of land above sea level also influences air temperatures.
15 min	**Activity:** Students read a story about a mountain-climbing expedition to Mount Everest and record elevation and temperature data. Then they use the elevation data to create an elevation profile.	• Air temperatures decrease as elevation increases, resulting in cooler temperatures at higher elevations.
6 min	**Follow-up to activity:** Students share the temperature patterns they observed in the story as elevation increased and discuss why air density might affect air temperature.	• Higher elevations generally experience cooler temperatures because the air at higher elevations in less dense and absorbs less heat.
10 min	**Synthesize/summarize today's lesson:** Students synthesize their understandings of factors other than latitude that influence temperature patterns on Earth. The teacher concludes with a summary of key science ideas from the lesson.	• Many factors influence temperature patterns on Earth beyond latitude, including the curved surface of Earth, its consistent tilt, its orbit around the Sun, the angle at which sunlight strikes Earth's surface at different latitudes, elevation, and proximity to large bodies of water. These factors cause uneven heating on Earth and differences in regional climates.
1 min	**Link to next lesson:** The teacher announces that in the next lesson, students will use what they've learned about the Sun's effect on climate to answer challenging questions about temperature patterns around the world.	

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5 min	**Link to Previous Lesson** **Synopsis:** Students share the sentences they completed in the previous lesson regarding which temperature patterns for the three cities are consistent with proximity to a large body of water. **Main science idea(s):** • Factors other than latitude, such as elevation and proximity to large bodies of water, influence regional climates.	Engage students in analyzing and interpreting data and observations.	**Show slides 1 and 2.** Last time, we investigated the heating and cooling rates of soil and water. Then we graphed the temperature data and compared it with the data we collected for the three US cities in lesson 5. These three cities were at about the same latitude, and yet they had different temperature patterns throughout the year. At the end of the lesson, you and a partner completed three sentences explaining whether the temperature patterns for each city were or weren't consistent with being near a large body of water: The temperature patterns of San Francisco are [consistent/not consistent] with being near a large body of water because _____. The temperature patterns of Colorado Springs are [consistent/not consistent] with being near a large body of water because _____. The temperature patterns of St. Louis are [consistent/not consistent] with being near a large body of water because _____. Let's hear your conclusions and explanations for each city. Make sure to support your reasoning with evidence from the temperature data we collected. **NOTE TO TEACHER:** *Have students locate*	We said that the temperatures in San Francisco are consistent	

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			handouts 5.2 (Investigating Temperatures at the Same Latitude) and 6.1 (Uneven Heating, part 1). During this discussion, help students connect their reasoning to the line-graph temperature data for the three cities from lesson 5 and their soil and water temperature data in lesson 6a. Invite students to look at their science notebooks and handouts to refresh their memories. Make sure students realize that factors other than latitude, such as proximity to a large body of water, impact local and regional temperatures, and the influence of these factors can be seen in the temperature data. In today's lesson, elevation will be added to the list of factors that impact temperature patterns and regional climates.	with being near a large body of water because they don't change very much over the year. We learned last time that water heats and cools slower than soil does, so places near water would have more even temperatures during the year. The temperatures of Colorado Springs and St. Louis are a lot higher in the summer and are lower in the winter, so we didn't think that water affects them like in San Francisco.	Who agrees with this idea? Does anyone disagree? If so, tell us why. How does your idea relate to our investigation of soil and water temperatures? Let's review the temperature variations for Colorado Springs and St. Louis. Do we all agree with this analysis?
3 min	**Lesson Focus Question**		**Show slide 3.**		

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	Synopsis: The teacher introduces the focus question, *How does being near the ocean or at a higher elevation affect air temperature?* and notes the addition of elevation as a factor influencing temperature patterns. **Main science idea(s)**: • Factors other than latitude, such as elevation and proximity to large bodies of water, influence temperature patterns and regional climates.	Set the purpose with a focus question or goal statement.	Today's focus question is *How does being near the ocean or at a higher elevation affect air temperature?* How is this question different from our last focus question? Yes, elevation has been added as a factor that influences temperature patterns. Write today's focus question in your science notebooks and draw a box around it. **NOTE TO TEACHER:** *Post the focus question on the board or chart paper so that it's visible to students throughout the lesson.*		
5 min	**Setup for Activity** **Synopsis:** The teacher introduces the activity, explaining that students will create an elevation profile of Mount Everest and plot temperature data on a line graph. **Main science idea(s):** • The elevation of land above sea level also influences air temperatures.	Make explicit links between science ideas and activities **before** the activity. Ask questions to elicit student ideas and predictions.	**Show slide 4.** In the previous lesson, we investigated how being near a large body of water affects temperatures. Now that we know a little more about air temperatures near the ocean or other large bodies of water, we're going to investigate what happens to air temperatures at higher elevations. First, what does *elevation* mean? Why might higher elevations have different temperature patterns than lower elevations?	It's land that's higher up, like a hill or a mountain. I think being at a high elevation would be	What do you mean by "higher up"?

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			NOTE TO TEACHER: *Students might think that higher elevations are warmer because they're closer to the Sun. Remind them that the distance between lower and higher elevations on Earth are minuscule compared to the distance between Earth and the Sun.* Today we'll read a story about a mountain-climbing expedition to Mount Everest. As you track the team's progress through this story, you'll stop at specific points and record the elevation and temperature on a data table. At the end of the activity, you'll plot the elevation data for each location on an elevation profile and talk with a partner about the temperature patterns you observe. **Show slide 5.** To get an idea of what an elevation profile is, let's look at an example of Denali Park Road in Alaska. From the image on this slide, what do you think an elevation profile might be? **NOTE TO TEACHER:** *As you display the elevation profile of Denali Park Road on the slide, explain that it shows the elevation gain and loss at each point along the route. It's like a cross section of the land that tracks elevation changes.* After you create your elevation profiles, you'll discuss the questions on the handout with your partner.	warmer because it's closer to the Sun. But places at higher elevations have snow, so if they were warmer, the snow would melt. The side view of the land. Like a slice of land.	Does anyone else have an idea about elevation? By "side view," what do you mean? Does anyone else have ideas to add?

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15 min	**Activity** **Synopsis:** Students read a story about a mountain-climbing expedition to Mount Everest and record elevation and temperature data. Then they use the elevation data to create an elevation profile. **Main science idea(s):** • Air temperatures decrease as elevation increases, resulting in cooler temperatures at higher elevations.		**Show slide 6.** First, locate your Uneven Heating handout from our last lesson and silently read the overview for Part 2: Investigating Elevation on page 1. Then skip to the detailed instructions for part 2 and read the Collecting Data section on page 3. **NOTE TO TEACHER:** *After students read the first section of part 2 (Collecting Data) in handout 6.1, distribute handout 6.3 (Climb to Cold). Have students read the story silently or aloud as a class. As students read the story, walk around the room and make sure they're recording the data in the correct places on their data tables and using the correct elevation measurements (meters).* As you're reading through the story "Climb to Cold," pause when you see a stop sign and record the elevation and temperature data for each location on your data tables in handout 6.1. Make sure to look for temperature patterns related to changes in elevation. **Student reading and recording time.** **Show slide 7.** OK, now that you've finished reading the story and recording the elevation and temperature data on your data tables, let's quickly read the next section in your handouts about graphing your data.		

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			For this part of the activity, you'll create an elevation profile. First, plot on your graphs the elevation data for each location from your data tables. Then you'll write the temperature data next to the matching data point. Remember that not all locations have temperatures data. Finally you'll draw a line with a colored pencil to connect the points and shade in the area below the line. **Turn and Talk:** When you've finished your elevation profiles, look for patterns in the data. Then pair up and discuss the questions at the end of the handout with your partner. Be prepared to share your answers and evidence with the class. **NOTE TO TEACHER:** *Circulate around the room while students are creating their elevation profiles, and help them as needed.*		
6 min	**Follow-Up to Activity** **Synopsis:** Students share the temperature patterns they observed in the story as elevation increased and discuss why air density might affect air temperature. **Main science idea(s):** • Higher elevations generally experience cooler temperatures because the air at higher elevations is less dense	Engage students in analyzing and interpreting data and observations.	**Show slide 8.** Let's talk about your answers to the questions on pages 4 and 5 of your handouts. 1. What temperature patterns did you observe as the climbers traveled to the summit of Mount Everest?	The temperatures got colder as the elevation got higher. I thought it would get warmer because the climbers were closer to the Sun, but it actually	Did anyone else find that pattern? Does anyone else agree with that idea?

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	and absorbs less heat.			got colder.	Why do you think that now?
			2. Why might the climbers have had to wear oxygen masks as they approached the summit?	In the story, it said that the air was thinner, but I didn't really understand that. I guess that's why they might have had to wear oxygen masks at the top of Mount Everest.	Does anyone have any ideas about what "thin air" means?
			3. How do you think air density relates to air temperature?	I think air temperature has something to do with air density because the climbers had to wear oxygen masks at the top of Everest where it was really cold.	Can you tell me more about why you think air density might affect air temperature?
			4. Based on the elevation and temperature data you collected, how would explain why the air temperature gets colder at higher elevations?		
			NOTE TO TEACHER: *Students will likely struggle to come to the conclusion that air density affects air temperature. Air at higher*		

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			elevations holds less heat than air at lower elevations because the air is less dense. However, since this concept is beyond the scope of this lesson series, it isn't covered in any depth during the activity. At this point, it's more important for students to recognize this pattern: Temperatures decrease as elevation increases. Today we discovered how elevation affects air temperature. What key science idea did we learn from creating an elevation profile? **Show slide 9.** That's right! Here's another way to say it: As elevation increases, air temperatures decrease. So how do you think this science idea relates to our line-graph data for the three cities from lesson 5? Which city's temperature data gives us a clue about its elevation? Why do you think so?	We learned that air temperatures are cooler at higher elevations. Colorado Springs and St. Louis are at the same latitude and neither is near an ocean, but Colorado Springs must be at a higher elevation because it has cooler temperatures.	
10 min	**Synthesize/Summarize Today's Lesson** **Synopsis:** Students		**Show slide 10.** Now we're going to think about our soil and water investigation from the last lesson and		

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	synthesize their understandings of factors other than latitude that influence temperature patterns on Earth. The teacher concludes with a summary of key science ideas from the lesson. **Main science idea(s):** • Many factors influence temperature patterns on Earth beyond latitude, including the curved surface of Earth, its consistent tilt, its orbit around the Sun, the angle at which sunlight strikes Earth's surface at different latitudes, elevation, and proximity to large bodies of water. These factors cause uneven heating on Earth and differences in regional climates.	Engage students in constructing explanations and arguments.	today's elevation investigation. How might these two investigations help us explain why the average monthly temperatures are different in three cities located at the same latitude? **NOTE TO TEACHER:** *Invite students to look at their science notebooks and handouts from lessons 5a and 6a to refresh their memories.* **Think-Pair-Share-Write:** Think about the temperature data for San Francisco, Colorado Springs, and St. Louis and how these investigations might explain the different temperature patterns we observed. Why are temperatures in San Francisco steadier throughout the year than temperatures in the other cities? Why do temperatures change so much during the year in St. Louis and Colorado Springs compared to San Francisco? And why does Colorado Springs have cooler temperatures than St. Louis even though neither city is located near the ocean? Once you have a good idea of what might be causing these temperature differences, share your ideas with a partner and then write your ideas in your science notebooks using evidence from today's investigation to support your explanations. Be prepared to share your ideas with the class.		

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			NOTE TO TEACHER: *Give students time to think about these questions and then allow about 5 minutes for them to talk about their ideas with a partner and write their answers in their notebooks. To help students connect today's data with the temperature data from previous lessons, you might show them a visual like this:* *Explain:* Why are the average monthly temperatures different in three cities located at the same latitude? *Evidence:* Think about … • The city line-graph data • The soil and water temperatures • Data from "Climb to Cold" **Optional: Show slide 11.** ***Embedded Assessment Task*** *A correct student response will connect the slower absorption and release of heat in oceans to more steady air temperatures in places near oceans (San Francisco), while the quick absorption and release of heat in soil causes more extreme changes in air temperature (in places far from oceans like Colorado Springs and St. Louis). Elevation also influences air temperature, resulting in cooler temperatures overall (as in Colorado Springs).*		

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			NOTE TO TEACHER: *Make sure students aren't confusing the graphs of monthly average temperatures for the three US cities (from lesson 5a) with the graphs of water and soil temperatures from lesson 6a. The soil and water models demonstrate how land heats and cools faster in contrast with large bodies of water that absorb and reflect (release) solar energy more slowly than land. This moderates the climate in places near oceans, causing their air temperatures to remain steadier throughout the year. Inland locations experience more extreme temperature variations (on a daily basis as land heats and cools and on a yearly basis, since land loses heat much more quickly).* **Show slide 12.** **Whole-class share-out:** The questions you were just thinking about have to do with today's focus question, *How does being near the ocean or at a higher elevation affect air temperature?* Let's hear some of your ideas about why the average monthly temperatures are different in three cities located at the same latitude. Make sure to include evidence from our investigations! Why do you think temperatures change very little in places like San Francisco and quite a bit in places like Colorado Springs and St. Louis? And why do you think the temperatures in		
		Highlight key science ideas and focus question throughout.			

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			Colorado Springs are cooler than St. Louis even though neither city is near an ocean?	I think it's because water temperatures stay more steady in the ocean, so the air temperatures are more steady in places like San Francisco. Places that are surrounded by land heat up fast and lose heat fast, so they have hotter and cooler temperatures during the year. Well, it's really hot in St. Louis during the summer because the land absorbs all the Sun's energy. In the winter, St. Louis gets really cold because the land loses heat fast, and since the United States is tilted away from the Sun during the winter, St. Louis doesn't get as much heat from	Does anyone agree or disagree? Would anyone like to add or clarify something? What do you mean by "hotter and cooler temperatures"? Can someone else add to that idea?

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				the Sun as it does during the summer. Colorado Springs is at a higher elevation, and the data we plotted today showed that it gets colder at higher elevations.	Colorado Springs isn't close to the ocean, so why does it have cooler temperatures than St. Louis? Both cities are at the same latitude.
		Summarize key science ideas.	**Show slides 13–15.** Now we know that many different factors affect temperature patterns and regional climates. Let's review what we've learned so far: 1. Solar radiation hits Earth's curved surface at different angles based on latitude. The angle of sunlight is more direct closer to the equator and less direct closer to the poles. Places that receive more direct sunlight are warmer than places that receive less direct sunlight. 2. The consistent tilt of Earth on its axis changes where sunlight strikes the surface at different times of the year. When the Northern Hemisphere tilts toward the Sun, it receives more direct sunlight and experiences summer. When the Northern Hemisphere tilts		

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			away from the Sun, it receives less direct sunlight and experiences winter. Seasons in the Southern Hemisphere are opposite from seasons in the Northern Hemisphere. 3. Even though latitude is a key factor on climate, other factors influence regional temperature patterns, such as elevation or being near large bodies of water. Water absorbs and releases heat more slowly, so places near the ocean have more steady temperatures during the year. Land heats and cools more rapidly, so places that aren't near large bodies of water experience bigger temperature variations in the summer and winter. Elevation also affects temperatures, and higher elevations are typically cooler than lower elevations. Look through your science notebooks at what you've written about these important science ideas and think about whether you'd like to add or change anything. Make sure to write down any questions you still have. **NOTE TO TEACHER:** *By having students write down their questions, you can see what they might still be confused about and identify any misconceptions that need to be cleared up during the final lesson.*		
1 min	**Link to Next Lesson** **Synopsis:** The teacher announces that in the next	Make explicit links between	**Show slide 16.** In our next lesson, we'll see if we can answer some challenging questions about how the		

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	lesson, students will use what they've learned about the Sun's effect on climate to answer challenging questions about temperature patterns around the world.	science ideas and activities.	factors we've been talking about affect temperatures and climates around the world.		