

## The Sun's Effect on Climate and Seasons

### Lesson 6: Use and Apply



<b>Grade:</b> 5	<b>Length of lesson:</b> 67 minutes	<b>Placement of lesson:</b> 6 of 6 lessons
<p><b>Anchoring Phenomena:</b> Earth's Northern and Southern Hemispheres experience repeating, predictable seasonal changes in average temperatures.</p>		
<p><b>Unit Learning Goal:</b> Earth's curved surface and consistent tilt and its orbit around the Sun result in uneven heating across the planet. This difference in the sunlight's intensity causes different locations on Earth to experience different seasons at the same time of the year, as well as varying average yearly temperatures.</p>		
<p><b>Main learning goal:</b> Because of the curvature of Earth and Earth's tilt, the sunlight that strikes Earth's surface changes at different times of the year, causing uneven heating. Latitude, the distance above or below the equator, is the main factor influencing climate. Earth's tilt is consistent throughout its orbit, causing the Northern Hemisphere to tilt toward the Sun in June–August, summer. The Southern Hemisphere tilts toward the Sun during December–February, causing it to be summer opposite of the Northern Hemisphere. Winter in each hemisphere occurs oppositely for the same reason.</p> <p><b>Science and Engineering Practices:</b> Constructing Explanations and Designing Solutions: Construct an explanation using models or representations; Apply scientific ideas, principles, and/or evidence to construct, revise, and/or use an explanation for real-world phenomena, examples, or events; Engaging in Argument from Evidence: Respectfully provide and receive critiques about one's explanation, procedures, models, and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail.</p> <p><b>Crosscutting Concepts:</b> Patterns: Graphs and charts can be used to identify patterns in data; Cause and Effect: Cause and effect relationships may be used to predict phenomena in natural or designed systems.</p>		
<p><b>Unit Central Question:</b> Why are some places on Earth hotter than others at different times of the year?</p>		<p><b>Lesson Focus Questions:</b> Why are some places on Earth hotter than others at different times of the year? How can we use what we have learned to answer our Unit Central Question?</p>
<p><b>Science content storyline:</b> Some places on Earth are hotter than others at different times of the year because of variations that result from the tilt of Earth on its axis, the angle of the Sun's light (solar radiation) striking Earth's surface, and Earth's orbit around the Sun. The angle of the Sun's light, and thus the intensity of the solar radiation, depends on how far north or south of the equator a place is, its latitude. The angle and intensity of the Sun's light also varies by time of year. For example, when a hemisphere is tilted away from the Sun during its winter, the Sun's rays strike at a less direct angle which spreads the sunlight over a larger area and results in less heating and cooler temperatures. When a hemisphere is tilted toward the Sun during its summer, the solar radiation strikes Earth more directly, resulting in more concentrated energy and thus more heating of Earth's surface and higher temperatures. Because Earth's tilt is consistent throughout its orbit, summer in the Northern Hemisphere occurs in June–August and winter in December–February. The Southern Hemisphere is opposite, experiencing summer during December–February and winter in June–August. Earth is heated unevenly, causing some places to be hotter than others due to many measurable factors, including consistent tilt, orbit, and angle of the Sun's energy striking the surface of Earth.</p>		

**Ideal student response to the Lesson Focus Questions:** Some places on Earth are hotter than others because they are closer to the equator. The temperatures vary depending on how far north or south a place is from the equator. Places have higher average temperatures closer to the equator and lower average temperatures as latitudes increase and we move toward the poles. Because Earth is curved, the Sun’s rays hit more intensely at the equator and are more spread apart as you move away from the equator. Some places are also hotter at different times of the year because the consistent tilt of Earth as it orbits around the Sun causes the Sun’s light to be more intense in some places, causing summer, while it is less intense in other places, causing winter. The Northern Hemisphere tilts toward the Sun during June–August, so it is summer. The Southern Hemisphere is just the opposite; it is tilted toward the Sun during December–February, so it is summer there when we are having winter. This is because Earth’s tilt remains consistent as it orbits the Sun.

**Preparation**

MATERIALS NEEDED	AHEAD OF TIME
<p><b>Sun’s Effect on Climate and Seasons PowerPoint (by lesson)</b></p> <p><b>Student Handout</b></p> <ul style="list-style-type: none"> <li>HO6.1 <i>Team Challenges—Why are some places on Earth hotter than others at different times of the year?</i> (1 per group)</li> </ul> <p><b>Other Materials</b></p> <ul style="list-style-type: none"> <li>Earth-Sun model from Lesson 3 (1 per group of 4-5 students)</li> <li>Chart paper</li> <li>Student Ideas chart from Lesson 5</li> </ul>	<ul style="list-style-type: none"> <li>Review the <i>Content Background</i> document as necessary.</li> <li>You might choose to cut apart the Team Challenges and glue them onto index cards so that you can distribute one challenge at a time to each team. Or copy 1 handout per team of 3 and have them put a star next to their assigned challenge.</li> <li>Arrange the Earth-Sun model stations around the classroom, 1 setup per group of 4-5 students.</li> </ul>

## Lesson 6 General Outline

Time	Phase of lesson	How the science content storyline develops
5 min	<p><b>Link to Previous Lessons:</b> Students connect key science ideas from previous lessons about the Sun’s effect on climate and seasons.</p>	<p>Some places on Earth are hotter than others at different times of the year because of variations that result from the tilt of Earth on its axis, the angle of the Sun’s light (solar radiation) striking Earth’s surface, and Earth’s orbit around the Sun.</p>
2 min	<p><b>Unit Central Question and Lesson Focus Questions:</b> The teacher reminds students of the Unit Central Question, <i>Why are some places on Earth hotter than others at different times of the year?</i>, and the Lesson Focus Questions, <i>Why are some places on Earth hotter than others at different times of the year? How can we use what we have learned to answer the Unit Central Question?</i></p>	
5 min	<p><b>Setup for Activity:</b> The teacher sets up four team challenges related to the Unit Central Question.</p>	
20 min	<p><b>Activity:</b> Students work on one or more challenges in their team and write their responses using complete sentences in their science notebook.</p>	<p>The angle of the Sun’s light, and thus the intensity of the solar radiation, depends on how far north or south of the equator a place is, its latitude. The angle and intensity of the Sun’s light also varies by time of year. For example, when a hemisphere is tilted away from the Sun during its winter, the Sun’s rays strike at a less direct angle which spreads the sunlight over a larger area and results in less heating and cooler temperatures. When a hemisphere is tilted toward the Sun during its summer, the solar radiation strikes Earth more directly, resulting in more concentrated energy and thus more heating of Earth’s surface and higher temperatures. Because Earth’s tilt is consistent throughout its orbit, summer in the Northern Hemisphere occurs in June–August and winter in December–February. The Southern Hemisphere is opposite, experiencing summer during December–February and winter in June–August.</p>

Time	Phase of lesson	How the science content storyline develops
15 min	<b>Follow-up to Activity:</b> Students share their ideas about the effect angle of sunlight, Earth’s tilt, and orbit have on temperatures on Earth at different locations and at different times of year.	Earth is heated unevenly, causing some places to be hotter than others due to many measurable factors, including consistent tilt, orbit, and angle of the Sun’s energy striking the surface of Earth.
10 min	<b>Synthesize and Summarize Today’s Lesson:</b> Students return to the Unit Central Question and summarize their ideas by writing their “best answer” in their science notebook.	
10 min	<b>Link to Future Lessons on Climate and Weather:</b> This unit provides an important conceptual basis for future studies of weather and the causes of seasonal weather patterns.	

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
5 min	<p><b>Link to Previous Lessons</b></p> <p><u>Synopsis:</u> Students connect key science ideas from previous lessons about the Sun’s effect on climate and seasons.</p> <p><u>Main Science Idea:</u> Some places on Earth are hotter than others at different times of the year because of variations that result from the tilt of Earth on its axis, the angle of the Sun’s light (solar radiation) striking Earth’s surface, and Earth’s orbit around the Sun.</p>	Link science ideas to other science ideas.	<p>In the past few lessons, we have been learning about how the Sun’s light energy affects the temperatures on Earth.</p> <p>First, we collected and analyzed data about the angle of sunlight as it strikes Earth’s surface.</p> <p>What did we learn about the angle of sunlight as it strikes Earth’s surface? How does the angle affect the average temperature? Talk to a partner and look back at your science notebooks.</p> <p>Who would like to share their ideas?</p> <p><b>NOTE TO TEACHER:</b> <i>Students should understand that the Sun’s energy is more direct at the equator and more dispersed toward the poles. If students say “more light”, be sure to clarify that it is more direct, or more concentrated, light.</i></p>	<p>There’s more light at the equator so it’s hotter.</p> <p><b>What do you mean by “more light” or “not as much solar radiation”?</b></p> <p><b>Think back to our flashlight.</b></p> <p>There’s not as much solar radiation near the North and South Poles.</p> <p>Oh, we never changed the flashlight, so the amount of light was the same.</p> <p><b>What do others think about this?</b></p> <p><b>Can someone say more or add to this?</b></p> <p>The temperatures are opposite in the Northern and Southern Hemispheres.</p> <p><b>Tell us more about “opposite.</b></p> <p><b>Does anyone want to add to [student’s] ideas?</b></p>

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			<p>What did you learn when you modeled Earth orbiting the Sun?</p> <p><b>NOTE TO TEACHER:</b> Allow students to list 4 or 5 ideas that will get them started thinking about the important science ideas from this unit. You can probe their thinking briefly, but this initial discussion is designed to jog their memory, not to provide complete explanations. Take note of any misconceptions students express so you can follow up on those during and following the activity.</p>	<p>Earth is always tilted.</p> <p>It is one year around the Sun.</p> <p>Earth spins to make day and night.</p> <p>Earth's orbit is (nearly) circular so Earth is always same distance from the Sun.</p> <p><b>Does anyone agree or disagree or want to add on to this idea?</b></p> <p><b>What evidence do we have from our data for this claim?</b></p> <p><b>Does anyone else have something to add to this idea</b></p>
2 min	<p><b>Unit Central Question and Lesson Focus Questions</b></p> <p><u>Synopsis:</u> The teacher reminds students of the Unit Central Question, <i>Why are some places on Earth hotter than others at different times of the year?</i>, and the Lesson Focus Questions, <i>Why are some places on Earth hotter than others at different times of the year? How can we use what we have learned to answer the Unit Central Question?</i></p>	Set the purpose with a focus question.	<p>Remember our Unit Central Question: <i>Why are some places on Earth hotter than others at different times of the year?</i></p> <p>We have completed a number of activities and collected a lot of data that can help us answer that question.</p> <p>Today's Lesson Focus Questions will help us put all our ideas together: <i>Why are some places on Earth hotter than others at different times of the year? How can we use what we have learned to answer the Unit Central Question?</i></p> <p><b>NOTE TO TEACHER:</b> Add these focus questions to your list of Lesson Focus Questions, which are</p>	

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			<p><i>posted so you and the students can easily refer to them throughout the lesson.</i></p>	
5 min	<p><b>Setup for Activity</b>  <u>Synopsis:</u> The teacher sets up four team challenges related to the Unit Central Question.</p>		<p>You will work in small groups on one or more challenges that will give you a chance to express your understanding about why different places on Earth have different temperatures—why some places on Earth are hotter than others. Use the ideas that we just reviewed as you think about these challenges.</p> <p>Let’s review the challenges first and then find out how much we have learned.</p> <p><b>NOTE TO TEACHER:</b> <i>Divide students into teams of 3. Distribute the handout to each team or cut apart the challenges and hand one challenge to each team. Review the challenges to make sure students understand the tasks.</i></p> <p><i>Assign one challenge per team and then add additional challenges to teams as time allows. Ideally, each group will respond to each challenge.</i></p> <p>You may talk about your ideas first. Then, individually write your answers in sentences in your science notebook.</p> <p>Please include labeled diagrams or drawings to help explain your ideas. Remember, we have observed many patterns throughout our lessons and discussed cause-effect relationships. Please include these, too, in your explanations.</p>	

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
20 min	<p><b>Activity</b></p> <p><u>Synopsis:</u> Students work on one or more challenges in their team and write their responses using complete sentences in their science notebook.</p> <p><u>Main Science Ideas:</u> The angle of the Sun’s light, and thus the intensity of the solar radiation, depends on how far north or south of the equator a place is, its latitude. The angle and intensity of the Sun’s light also varies by time of year. For example, when a hemisphere is tilted away from the Sun during its winter, the Sun’s rays strike at a less direct angle which spreads the sunlight over a larger area and results in less heating and cooler temperatures. When a hemisphere is tilted toward the Sun during its summer, the solar radiation strikes Earth more directly, resulting in more concentrated energy and</p>	Engage students in using and applying new science ideas in a variety of ways and contexts.	<p><b>NOTE TO TEACHER:</b> Encourage teams to use the handouts and their science notebook writings from previous lessons.</p> <p>Allow them to use the Sun-Earth model if it will help them picture what might be happening within each challenge scenario.</p> <p>As students work, look to see if you can understand their writing and drawings without any clarification. Challenge students to clearly explain themselves through their writing and drawings. Ask questions if you cannot understand their sentences or drawings.</p>	



Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
	<p>thus more heating of Earth’s surface and higher temperatures. Because Earth’s tilt is consistent throughout its orbit, summer in the Northern Hemisphere occurs in June–August and winter in December–February. The Southern Hemisphere is opposite, experiencing summer during December–February and winter in June–August.</p>			
15 min	<p><b>Follow-up to Activity</b>  <u>Synopsis:</u> Students share their ideas about the effect angle of sunlight, Earth’s tilt, and orbit have on temperatures on Earth at different locations and at different times of year.  <u>Main Science Ideas:</u> Earth is heated unevenly, causing some places to be hotter than others due to many measurable factors, including consistent tilt, orbit, and angle of the Sun’s</p>	<p>Engage students in using and applying new science ideas in a variety of ways and contexts.</p> <p>Highlight key science ideas and focus question throughout.</p>	<p>Let’s share our ideas about the challenges.</p> <p><b>Challenge #1:</b> Explain why the average summer temperature in Barrow, Alaska, is 45°F even though there are 24 hours of sunlight while Lagos, Nigeria, with only 12 hours of sunlight a day, reaches a temperature of 82°F.</p> <p><b>NOTE TO TEACHER:</b> <i>As students share their responses, take time to highlight key science ideas from the “ideal student responses” as appropriate. Encourage students to change or add to their ideas as you discuss each challenge.</i></p>	<p><u>Ideal Student Response to Challenge #1</u></p> <p>Even though Barrow, Alaska, experiences 24 hours of sunlight in the summer, with no darkness, the sunlight intensity is much lower than in Lagos, Nigeria. Barrow is further from the equator, so the Sun’s rays strike the surface at a lower angle and are more dispersed because of Earth’s curvature. Lagos is closer to the equator, so the</p>

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
	energy striking the surface of Earth.		<p><b>Challenge #2:</b> What do you notice about the temperatures in Belem, Brazil? Why do you think Belem, Brazil, does not have summer and winter like we do in the United States?</p> <p><b>Challenge #3:</b> Why is the average temperature higher in Santa Rosa, Argentina, when the average temperature in Richmond, Virginia is lower? Why is the average temperature lower in Santa Rosa, Argentina, when the average temperature in Richmond, Virginia is higher?</p>	<p>Sun’s rays are more direct and more intense. So, even though there are fewer hours of sunlight, it is much more intense than in Barrow.</p> <p><u>Ideal Student Response to Challenge #2</u></p> <p>The temperatures in Belem, Brazil, change only one degree all year long. This is because sunlight is more direct (concentrated) near the equator all year long. Because there is not much change in the angle of sunlight, the temperatures would stay consistently warm all year long. Because the average temperature all year long is fairly consistent, there are no seasons.</p> <p><u>Ideal Student Response to Challenge #3</u></p> <p>Santa Rosa, Argentina, is in the Southern Hemisphere, and Richmond, Virginia, is in the Northern Hemisphere. When it is winter in the Northern Hemisphere, the Southern Hemisphere experiences summer because the Southern Hemisphere is tilted toward the Sun (position 3 in our orbit). The Sun’s light strikes the</p>

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
			<p><b>Challenge #4:</b> Which friend do you most agree with? Describe your thinking about why it is warmer in the summer than in the winter</p> <p><b>NOTE TO TEACHER:</b> <i>It is possible that many students still hang on to the misconception that Earth is closer to the Sun in the summer than in the winter. If you realize that is the case, then you might revisit Lesson 3 and the Earth-Sun model.</i></p>	<p>Southern Hemisphere of Earth at a more-direct angle during the summer, so the Sun’s energy is less spread out. This increases the intensity of sunlight and warms Earth’s surface more in Argentina. In position 1, the reverse happens—Richmond is tilted toward the Sun and has summer while Santa Rosa is tilted away from the Sun and experiences winter.</p> <p><u>Ideal Student Response to Challenge #4</u></p> <p>Raul’s answer is the only reasonable answer. It’s because Earth’s tilt changes the angle of sunlight hitting Earth. The summers are warmer (with higher average temperatures) because that is when Earth is tilted most toward the Sun (in the Northern Hemisphere), and it is colder in the winter because that is when the Northern Hemisphere is tilted away from the Sun. It is opposite for the Southern Hemisphere.</p>
10 min	<p><b>Synthesize and Summarize Today’s Lesson</b></p> <p><u>Synopsis:</u> Students return to the Unit Central Question</p>	Engage students in making connections by	Let’s return to our Unit Central Question: <i>Why are some places on Earth hotter than others at different times of the year?</i>	

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
	and summarize their ideas by writing their “best answer” in their science notebook.	synthesizing and summarizing key science ideas.	<p>Look over your notes in your science notebook from our lessons about the Sun’s effect on Earth’s climate and seasons.</p> <p>First, take a few minutes to think about how you would answer this central question. Share a few ideas with a partner.</p> <p>Then, write in your science notebook your best answer to the Unit Central Question.</p> <p>Think about the two parts to the question: (1) Why are some places hotter than others, in general? (2) Why are some places hotter at different times of the year?</p> <p>As you respond to our Unit Central Question, include the ideas we’ve discussed in each of our lessons:</p> <ul style="list-style-type: none"> <li>• Angle of sunlight and how sunlight can be spread out or more concentrated</li> <li>• Tilt of Earth</li> <li>• Orbit of Earth around the Sun</li> <li>• Length of daytime</li> <li>• Labeled diagram (model)</li> <li>• Patterns that apply</li> <li>• Cause-effect relationships</li> </ul>	
10 min	<p><b>Link to Future Lessons on Climate and Weather</b></p> <p><u>Synopsis</u>: This unit provides an important conceptual basis for future studies of</p>		<p>The lessons in this unit have been about how the Sun’s energy heats places on Earth unevenly.</p> <p>The seasonal climate—whether it’s hot or cold at certain times of the year—greatly influences the daily weather. The seasonal climate is what is predictable over time, and the weather is the</p>	

Time	Phase of lesson and how the science content storyline develops	STeLLA strategy	Teacher talk and questions	Possible student and teacher dialogue
	weather and the causes of seasonal weather patterns.		<p>amount of daily variability within the seasonal climate.</p> <p>What we have learned about in this unit is why we have the climate we have where we live. Once we understand our climate, we can more easily understand and predict our daily weather patterns.</p> <p>We also developed and used models throughout this unit: How did developing and using models support your learning throughout this unit?</p> <p><i>Provide a few minutes for students to think and discuss in their small groups. Gather ideas from at least a few groups.</i></p> <p>How did using the Communicating in Scientific Ways strategies help you learn?</p>	





Transforming Science Education Through Research-Driven Innovation

## Lesson 6

### The Sun's Effect on Climate and Seasons



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#### Link to previous lessons

In past few lessons, we have been learning about how the Sun's light energy affects the temperatures on Earth.

With your partner, talk about these questions:

- What did we learn about the angle of sunlight as it strikes Earth's surface?
- How does the angle affect the average temperature?



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#### Lesson Focus Questions

**Why are some places on Earth hotter than others at different times of the year?  
How can we use what we have learned to answer our Unit Central Question?**



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#### Unit Central Question

**Why are some places on Earth hotter than others at different times of the year?**



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#### Lesson Focus Questions

We have completed activities and collected a lot of data to help us answer our Unit Central Question: *Why are some places on Earth hotter than others at different times of the year?*

Today's Lesson Focus Questions will help us put all our ideas together.



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#### Introduction to Today's Challenges

In small groups, you will work on one or more assigned challenges to show your understanding about why different places on Earth have different temperatures.

To do this, you will use the ideas we reviewed today as you think about the challenges.



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## Today's Challenges

### Challenge #1

Explain why the average summer temperature in Barrow, Alaska, is 4 5°F even though there are 24 hours of sunlight while Lagos, Nigeria, with only 12 hours of sunlight a day, reaches a temperature of 82°F.

### Challenge #2

What do you notice about the temperatures in Belem, Brazil? Why do you think Belem, Brazil, does not have summer and winter like we do in the United States?

### Challenge #3

Why is the average temperature higher in Santa Rosa, Argentina, when the average temperature in Richmond, Virginia is lower? Why is the average temperature lower in Santa Rosa, Argentina, when the average temperature in Richmond, Virginia is higher?

### Challenge #4

Which friend do you most agree with? Describe your thinking about why it is warmer in the summer than in the winter.



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## Today's Challenges

What to do:

- First, talk to your team about your ideas related to your assigned challenge.
- Then, write your answers individually in sentences in your science notebook.
- Include labeled diagrams and/or drawings to help explain your ideas.
- Also include any patterns we have observed and cause-effect relationships we discussed throughout our lessons.



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## Today's Challenges

Let's share our ideas about the challenges.

### Challenge #1

Explain why the average summer temperature in Barrow, Alaska, is 4 5°F even though there are 24 hours of sunlight while Lagos, Nigeria, with only 12 hours of sunlight a day, reaches a temperature of 82°F.

### Challenge #2

What do you notice about the temperatures in Belem, Brazil? Why do you think Belem, Brazil, does not have summer and winter like we do in the United States?

### Challenge #3

Why is the average temperature higher in Santa Rosa, Argentina, when the average temperature in Richmond, Virginia is lower? Why is the average temperature lower in Santa Rosa, Argentina, when the average temperature in Richmond, Virginia is higher?

### Challenge #4

Which friend do you most agree with? Describe your thinking about why it is warmer in the summer than in the winter.



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## Lesson Summary

Let's return to our Unit Central Question: *Why are some places on Earth hotter than others at different times of the year?*

Think about the two parts to the question:

- 1) Why are some places hotter than others, in general?
- 2) Why are some places hotter at different times of the year?



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## Lesson Summary

Share a few ideas with your partner. Include the ideas discussed in each of our lessons:

- Angle of sunlight or sunlight spread out or more concentrated
- Tilt of Earth
- Orbit of Earth around the Sun
- Length of daylight
- Labeled diagram (model)
- Patterns that apply
- Cause-effect relationships



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## Link to Future Lessons on Climate and Weather

- Seasonal climate--whether it is hot or cold at different times of the year--greatly influences the daily weather.
- Seasonal climate is predictable over time, and weather is the amount of daily variability within the seasonal climate.



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**Meta Moment**

- How did developing and using models support your learning throughout this unit?
- How did using the Communicating in Scientific Ways strategies help you learn?



Communicating in Scientific Ways	
What a scientist does	What a scientist says
1. Identify and form questions	Hypothesis: ...? Evidence: ...? Reasoning: ...? How do they know that...?
2. Observe	Data: ... Trend: ... Conclusion: ...
3. Organize data and observations look for patterns	Form a pattern: ... Observe a relationship between ... Form a relationship between ... Use a model for ...
4. Think of an idea that explains your data and observations	My idea: ... Evidence: ... will happen because ... Reasoning: ... I could show a picture to explain my idea ...



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## TEAM CHALLENGES

Why are some places on Earth hotter than others at different times of the year?

### Challenge #1

Barrow, Alaska, is located at latitude  $71^{\circ}$  N. In July, during the summer, people who live in Barrow get 24 hours of sunlight every day. That means that the Sun shines all the time and it never gets dark.

In July, the average high temperature in Barrow, Alaska, is  $45^{\circ}\text{F}$ .

Lagos, Nigeria, is located at latitude  $6^{\circ}$  N. In July, during the summer, people who live in Lagos experience 12 hours of daylight and 12 hours of darkness each day.

In July, the average high temperature in Lagos, Nigeria, is  $82^{\circ}\text{F}$ .

Explain why the average summer temperature in Barrow, Alaska, is  $45^{\circ}\text{F}$  even though there are 24 hours of sunlight while Lagos, Nigeria, with only 12 hours of sunlight a day, reaches a temperature of  $82^{\circ}\text{F}$ .

### Challenge #2

The city of Belem, Brazil, is located at latitude  $1^{\circ}$  S, which is almost at the equator.

In the table below are the average high temperatures in Belem, Brazil, during one year.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
$78^{\circ}\text{F}$	$78^{\circ}\text{F}$	$78^{\circ}\text{F}$	$78^{\circ}\text{F}$	$79^{\circ}\text{F}$	$79^{\circ}\text{F}$	$78^{\circ}\text{F}$	$79^{\circ}\text{F}$	$79^{\circ}\text{F}$	$79^{\circ}\text{F}$	$79^{\circ}\text{F}$	$79^{\circ}\text{F}$

What do you notice about the temperatures in Belem, Brazil?

Why do you think Belem, Brazil, does not have summer and winter like we do in the United States?

**Challenge #3**

The city of Santa Rosa, Argentina, is located at latitude 37° S.

The city of Richmond, Virginia, USA, is located at latitude 37° N.

In the table below are the average high temperatures in those two cities during one year.

	January	March	May	July	September	November
Santa Rosa, 37° S latitude	74°F	67°F	52°F	45°F	54°F	67°F
Richmond, 37° N latitude	38°F	48°F	66°F	78°F	70°F	49°F

Why is the average temperature higher in Santa Rosa, Argentina, when the average temperature in Richmond, Virginia is lower?

Why is the average temperature lower in Santa Rosa, Argentina, when the average temperature in Richmond, Virginia is higher?

**Challenge #4**

*Think about positions 1, 2, 3, and 4 as Earth orbits the Sun.*

Four friends were sharing their ideas about why it is warmer in the summer than in the winter. This is what they said:

Ava: "It's because the Sun gives off more heat in the summer than in the winter."

Raul: "It's because Earth's tilt changes the angle of sunlight hitting Earth."

John: "It's because Earth orbits closer to the Sun in the summer than in the winter."

Shakira: "It's because one side of Earth faces the Sun and the other side faces away."

Which friend do you most agree with? \_\_\_\_\_

Describe your thinking about why it is warmer in the summer than in the winter.\*

*\*Challenge #4 is adapted from Keeley, P., Eberle, F., Dorsey, C. (2008). "Summer Talk" in Uncovering Student Ideas in Science: Another 25 Formative Assessment Probes. Arlington, VA: NSTA Press.*