The Sun's Effect on Climate Lessons: Scope and Sequence

Lesson Number	Focus Question(s)	Main Learning Goal	Science Content Storyline
1a	What temperature patterns can you find on Earth at different latitudes?	Temperatures on Earth's surface vary according to latitude.	The Sun's light energy—solar radiation—heats the surface of Earth. In general, temperatures on Earth vary according to latitude and time of year. Related to latitude, temperatures generally increase as latitude decreases (from the poles toward the equator) and generally decrease as latitude increases (from the equator toward the poles). Related to the time of year, temperatures are higher in the Northern Hemisphere from about June through September and in the Southern Hemisphere from about December through March. In other words, Earth's surface heats unevenly at different latitudes and times of the year.
1b	What temperature patterns can you find on Earth at different times of the year?	Temperatures on Earth's surface vary according to latitude and time of year.	
2a/b	Why are places closer to Earth's equator hotter than places farther away from the equator?	Because Earth is a sphere, sunlight hits the curved surface more directly closer to the equator and less directly closer to the poles. Variations in the angle at which sunlight strikes Earth's surface at different latitudes create uneven heating.	Light is a form of energy. On Earth, light from the Sun supplies energy to heat the planet and maintain temperatures. Earth's surface heats unevenly because sunlight (solar radiation or light energy) strikes different parts of the planet more directly or less directly depending on latitude. When light hits a surface more directly (almost straight on or perpendicular to the surface), the energy is more intense and concentrated over a smaller area. When light hits a surface at a less direct angle, the energy is more spread out and less intense. Because Earth is a sphere, sunlight hits the curved surface more directly closer to the equator and less directly closer to the poles. Solar radiation is most direct at, or close to, the equator and thus produces warmer temperatures. Farther from the equator and closer to the poles, solar radiation is less intense, and sunlight strikes Earth at less direct angles, resulting in cooler temperatures.
3a	Why is it summer in the United States (the Northern Hemisphere) when it's winter in Argentina (the Southern Hemisphere)?	Earth tilts on its axis as it orbits the Sun. This tilt produces opposite seasons in the Northern and Southern Hemispheres during the same time of year.	By 6th grade, many students already know that (1) Earth orbits the Sun once a year, and (2) Earth is tilted on its axis at 23.5 degrees from a line perpendicular to its orbital plane around the Sun. However, most students don't realize that Earth's tilt causes opposite seasons in the Northern and Southern Hemispheres. When the Northern Hemisphere leans toward the Sun, locations in that hemisphere experience summer, and locations in the Southern

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			Hemisphere experience winter. Conversely, when the Southern Hemisphere leans toward the Sun, locations in that hemisphere experience summer, and locations in the Northern Hemisphere experience winter. (Note that the seasonal variations we call *summer* and *winter* don't occur at latitudes closest to the equator.) Spring and fall occur when the hemispheres lean neither toward nor away from the Sun along Earth's orbit.
3b	Why is it summer in the United States (the Northern Hemisphere) when it's winter in Argentina (the Southern Hemisphere)?	The consistent tilt of Earth on its axis produces opposite seasons in the Northern and Southern Hemispheres during the same time of year.	By 6th grade, many students already know that (1) Earth orbits the Sun once a year, and (2) Earth is tilted on its axis at 23.5 degrees from a line perpendicular to its orbital plane around the Sun. However, most students don't understand that as Earth travels around the Sun in a nearly circular orbit, its axis always tilts in the same direction—toward the North Star. This consistent tilt causes the Northern Hemisphere to lean *toward* the Sun at certain times of the year—specifically during June, July, and August—and *away* from the Sun at other times of the year—during the months of December, January, and February. When the Northern Hemisphere leans toward the Sun, locations in that hemisphere experience summer, and locations in the Southern Hemisphere experience winter. Conversely, when the Southern Hemisphere leans toward the Sun, locations in that hemisphere experience summer, and locations in the Northern Hemisphere experience winter. (Note that the seasonal variations we call *summer* and *winter* don't occur at latitudes closest to the equator.) Spring and fall occur when the hemispheres lean neither toward nor away from the Sun along Earth's orbit.
4a/b	Why is it warmer in the summer than in the winter?	Earth's consistent tilt and the angle at which sunlight strikes the surface at different times of the year cause the Northern and Southern Hemispheres to experience varying intensities of sunlight and, as a result, opposite periods	Because of Earth's tilt, the Sun at the equator isn't directly overhead (at a perpendicular angle) at midday all year long. In fact, this happens only twice a year—March 21 and September 21—during the solar equinoxes. On June 21, the Sun is directly overhead at midday at 23.5° N latitude—the Tropic of Cancer—and on December 21, the Sun is directly overhead at midday at 23.5° S latitude—the Tropic of Capricorn. The latitude (in degrees) north and south of the equator is the same as the angle (in degrees) of Earth's tilt. This change in the angle of sunlight over time means that an entire hemisphere receives

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		of warmer and cooler temperatures (seasons).	more direct sunlight at certain times of the year, specifically during the summer months. So the Sun's energy is more concentrated (intense) in the Northern Hemisphere from June through August, and that hemisphere experiences warmer temperatures (summer). Conversely, the Sun's energy is more concentrated (intense) in the Southern Hemisphere from December through February, and that hemisphere experiences warmer temperatures (summer). When the Northern Hemisphere leans away from the Sun, the sunlight is more spread out, resulting in cooler temperatures (winter). The same thing happens when the Southern Hemisphere leans away from the Sun. Thus, the angle of sunlight related to Earth's tilt is one critical factor in determining temperatures and seasons around the globe.
5a/b	Why do some places at the same latitude have different temperature patterns?	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.	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.
6a	How does being near the ocean or another large body of water affect air temperature?	Water absorbs and reflects (releases) the Sun's energy at different rates than land. These variations in heating and cooling rates influence regional climates by affecting average air temperatures.	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,
6b	How does being near the ocean or at a	Water and land absorb and reflect (release) the Sun's	

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	higher elevation affect air temperature?	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.	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.
7a/b	How can we use what we've learned about the Sun's effect on climate to answer the unit central question?	Because of Earth's curved surface and consistent tilt, the angle of sunlight hitting the surface varies at different times of the year, causing uneven heating. While latitude is a key factor that influences climate on Earth, other factors are involved, such as elevation and proximity to large bodies of water.	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 sunlight (solar radiation) striking Earth's curved surface at different latitudes, and Earth's orbit around the Sun. First, the angle of sunlight, and thus the intensity of solar radiation, varies depending on latitude—the distance north or south from the equator. Second, the angle and intensity of sunlight vary by time of year. For example, when a hemisphere is tilted away from the Sun in the winter, the Sun's rays strike the surface at a less direct angle, spreading solar energy over a larger area, which results in less heating and cooler temperatures. When a hemisphere is tilted toward the Sun in the summer, sunlight strikes the surface at a more direct angle, resulting in more concentrated solar energy, increased heating, and higher temperatures. This produces seasonal temperature variations in the Northern and Southern Hemispheres. While latitude is a key factor influencing regional climates, other factors, such as elevation and proximity to large bodies of water, can cause variations in temperature patterns at the same latitude. All of these factors contribute to the uneven heating of Earth's surface, causing variations in temperature patterns and regional climates.