FYI The Seasons

As Earth moves around the sun, the angle between its axis of rotation and the ecliptic changes, and this causes Earth's seasons. During the portion of the year when the northern hemisphere is tilted toward the sun (around position A), the northern hemisphere experiences summer, while the southern hemisphere—which is tilted away from the sun—experiences winter. The reverse is also true. During the portion of the year when the northern hemisphere is tilted away from the sun (around position C), the northern hemisphere experiences winter, while the southern hemisphere—which is tilted toward the sun—experiences summer.

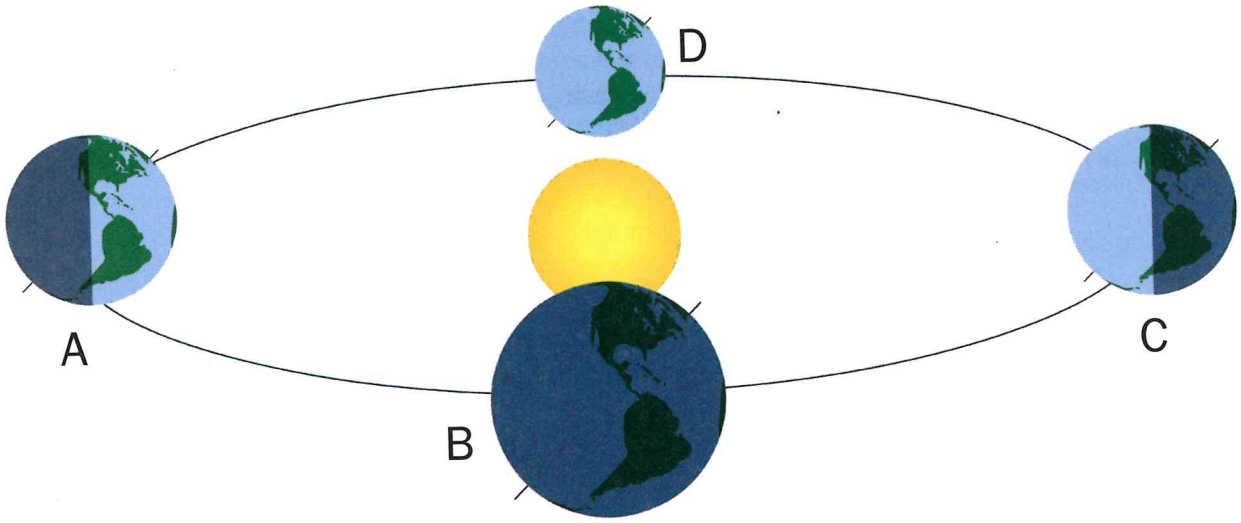

Figure 2-18: Diagram showing four important points in Earth's orbit around the sun related to different seasons. (NOT TO SCALE)

Being tilted toward or away from the sun matters because it affects the amount of sunlight or electromagnetic radiation reaching a region. Not only does sunlight not reach all locations at all times of year, but even the areas receiving sunlight experience different amounts.

Part of why different areas on Earth receive different amounts of sunlight is simply the result of day length. Days are longer in the hemisphere tilted toward the sun, and longer days means more sunlight reaching that hemisphere.

In areas on Earth where the sun is high in the sky, the sunlight comes straight down and the rays are concentrated on a small region, so that region receives more sunlight. In areas where the sun is lower in the sky, the sunlight comes in at a lower angle and the rays are spread over a larger region, so that region receives less sunlight.

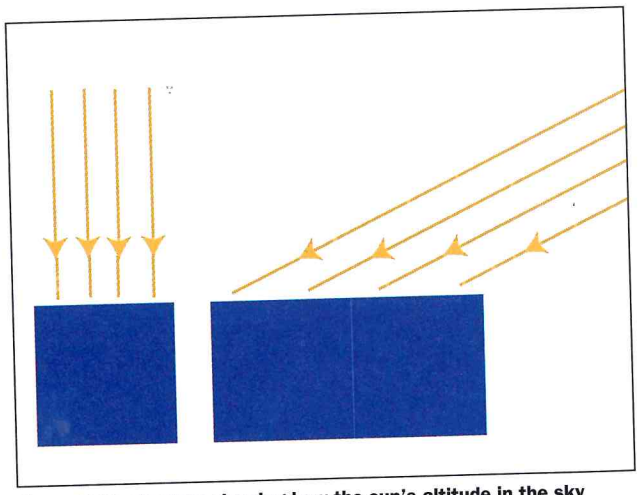

Figure 2-19: Diagram showing how the sun's altitude in the sky affects how much sunlight is received. The higher the sun, the more sunlight reaches a given area.

In turn, the amount of sunlight reaching an area affects the general temperature of that area. When light from the sun reaches Earth, some of that electromagnetic radiation is transformed into heat energy. The more sunlight reaching a region, the more energy is being received and transformed into heat, making the temperatures generally warmer.

Consider the following example. (See Figure 2-20.) It is June 21, the solstice, and the sun is directly overhead at the Tropic of Cancer (23.5° north).

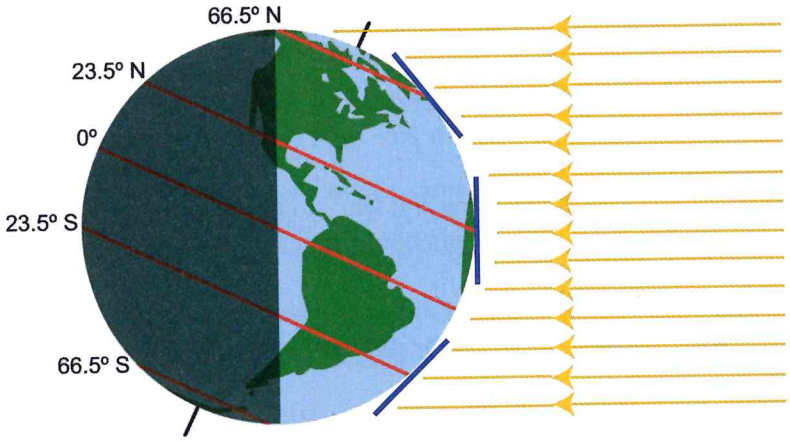

Figure 2-20: Diagram of how sunlight hits Earth when the North Pole is tilted toward the sun on the northern hemisphere's summer solstice

- At the location on the Tropic of Cancer where the sun is currently at transit, sunlight is coming straight down (from an altitude of 90°). This means that a large amount of sunlight is concentrated on that latitude, much of that sunlight is being transformed into heat, and the temperatures are generally high.
- At transit time for a more northern location, such as at 66.5° N, the sunlight is not coming straight down. It is coming in at a lower angle. However, while the angle of the sunlight is lower than at the Tropic of Cancer, it is still the highest angle that is ever experienced at 66.5° N! The resulting concentration of sunlight causes generally higher temperatures. It is the beginning of summer in the northern hemisphere.
- At transit time for a southern hemisphere location, such as at 23.5° S (the Tropic of Capricorn), the sunlight is coming in at the lowest angle that is ever experienced at that location. The amount of sunlight reaching the area is therefore also at its lowest, and the temperatures are generally lower than at other times of year. It is the beginning of winter in the southern hemisphere.

Some people wonder why the summer solstice is the beginning of summer and not the middle of summer. This seasonal lag is caused primarily by Earth's oceans. Because of the nature of water, the oceans heat up and cool down very slowly. It takes a lot of energy to heat water, and it takes the loss of a lot of energy to cool water. Therefore, on the solstices, the oceans are still in transition from cool to warm or warm to cool, and the peak cool or warm temperature for each season occurs about a month and a half after the solstice occurs.

Many people mistakenly believe that summer occurs when Earth is at the closest point in its orbit around the sun, and winter occurs when Earth is at its farthest point from the sun. This doesn't make sense, because when it is summer in the northern hemisphere, it is winter in the southern hemisphere, yet the distance between Earth and the sun is the same for both hemispheres. In fact, Earth is at its closest to the sun in January, which is winter in the northern hemisphere.

Checking In

1. Why do different areas on Earth receive different amounts of sunlight at different times of year?
2. What is the relationship between the height of the sun in the sky and the seasons?