

Earth's Tilt, Rotation, and the Causes of the Seasons



AZ State Standards

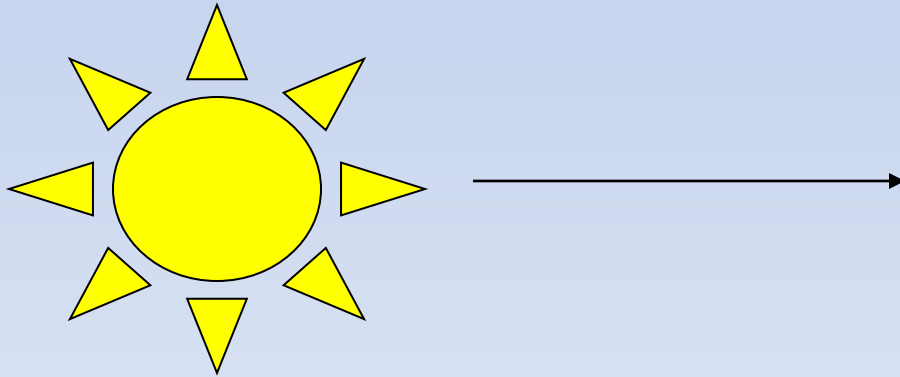
- **Concept 2: Energy in the Earth System (Both Internal and External)**
- Understand the relationships between the Earth's land masses, oceans, and atmosphere.
- PO 9. Explain the effect of heat transfer on climate and weather.
- PO 10. Demonstrate the effect of the Earth's rotation (i.e., *Coriolis effect*) on the movement of water and air
- PO 11. Describe the origin, life cycle, and behavior of weather systems (i.e., air mass, front, high and low systems, pressure gradients).

Content Objectives

- SWBAT explain why the tilt of the Earth causes the seasons.
- SWBAT predict what would happen to the Earth's climate patterns if the Earth did not rotate or were tilted in a different orientation.

Earth's Rotation

- The Earth rotates at a rate of a little over 1,000 mph.
- It is 25,000 miles around at the equator, so it takes 24 hours to rotate.
- Day and night are caused by rotation of the Earth.
- Half of the Earth is in darkness, and half of the Earth is in daylight at all times.



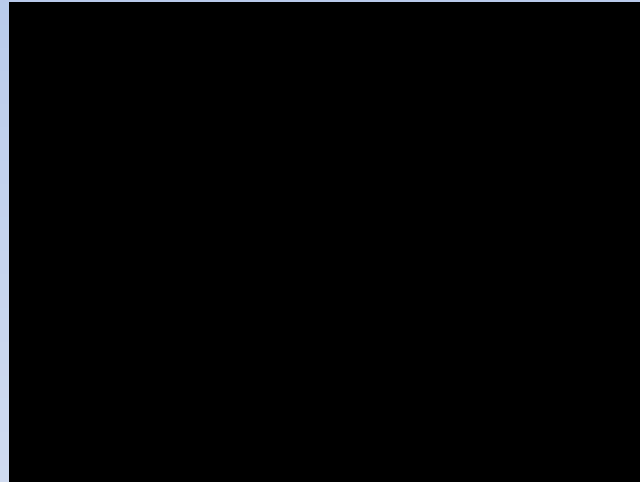
But, What Would Happen If the Earth Didn't Rotate?



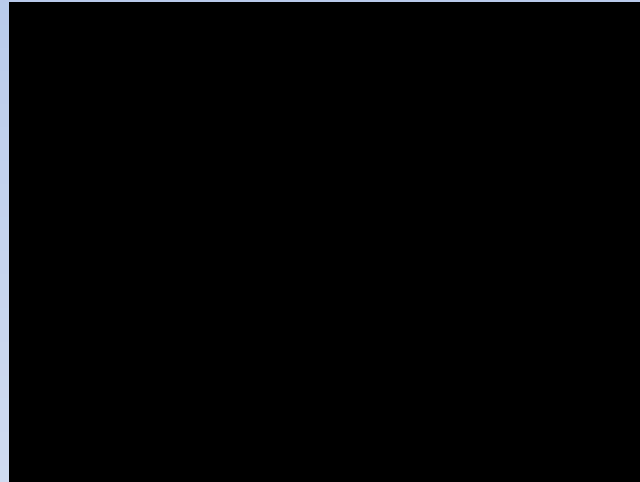
Let's Demonstrate

- Type of Rotation
- Earth Doesn't Rotate
- Synchronous Rotation
- Earth Rotates Rapidly
- Result
- Days are months in length and so are nights
- There is no day/night since the same side always faces the sun.
- Days are short and sun's energy is distributed evenly across the planet.

Let's Visualize It

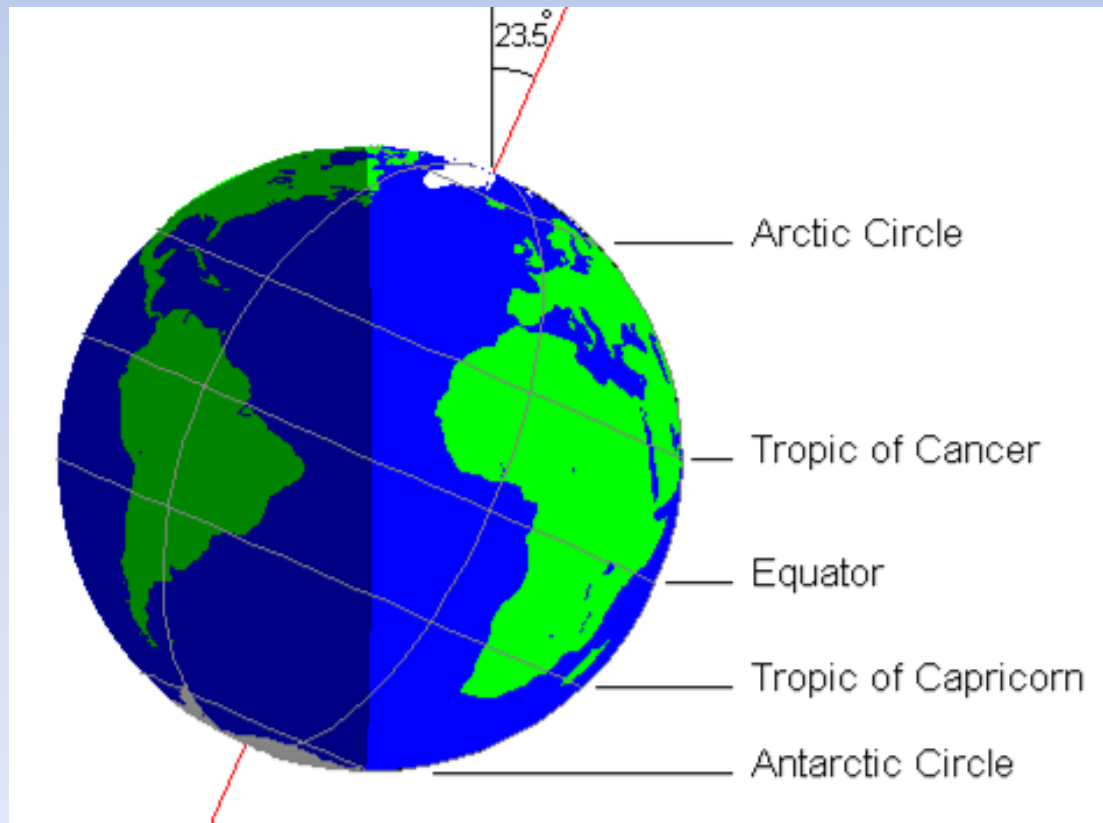


What Would Happen?



Earth's Axis and Tilt

- The Earth's axis is the line the planet spins on.
- This axis is tilted at an angle of 23.5° .
- This has a big impact on the distribution of energy hitting the Earth's surface



Earth on December 21st Winter Solstice



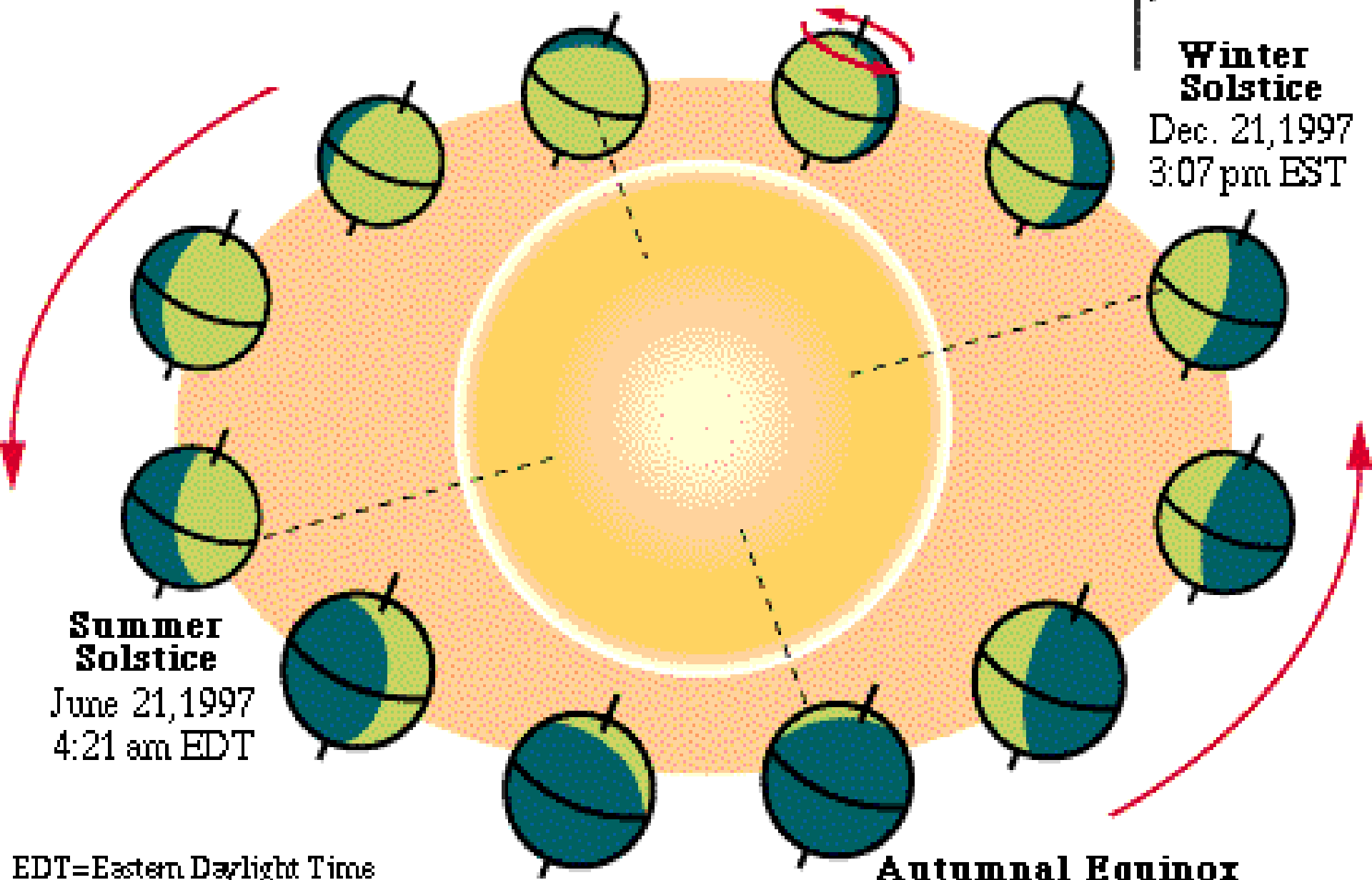
While distribution of light is different, at all times the $\frac{1}{2}$ of the Earth is lit and $\frac{1}{2}$ is dark

Vernal Equinox
March 20, 1997 8:56 am EST

North

Winter Solstice

Dec. 21, 1997
3:07 pm EST



Summer Solstice

June 21, 1997
4:21 am EDT

Autumnal Equinox

September 22, 1997 7:56 pm EDT

EDT=Eastern Daylight Time
EST=Eastern Standard Time

Seasonal Delay

Spring Equinox

Autumnal Equinox



- March 21st and September 21st have the same number of daylight hours (12 hrs)
- Why is it so much warmer in September?

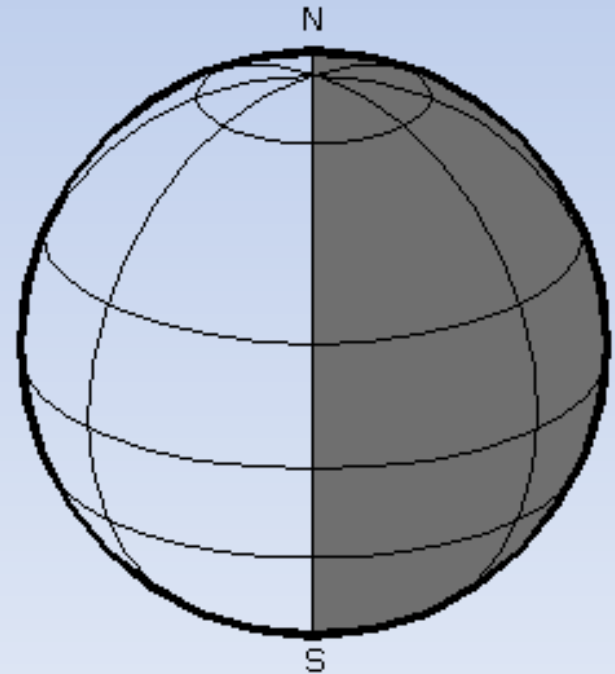
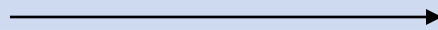
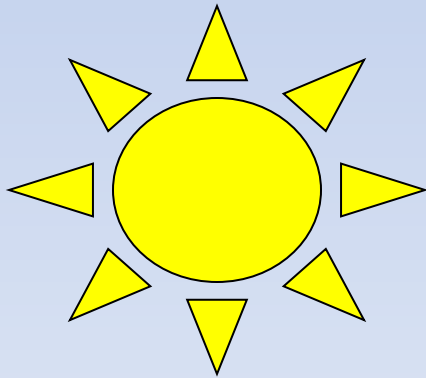
Seasonal Delay

- June 21st is the longest day of the year.
- Then why is July and August hotter than June?
- December 21st is the shortest day.
- Then why is January and early February the coldest time of year?



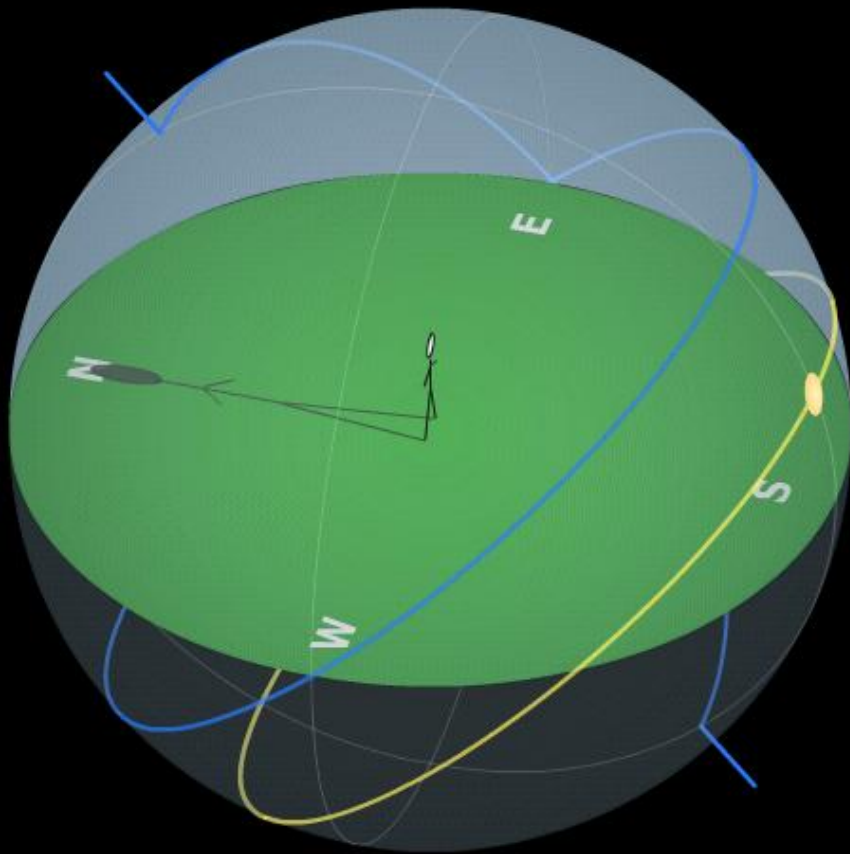
Significance of the Earth's Tilt

- If the Earth were not tilted, what would our seasons look like throughout the year?



Winter Solstice

Motions of the Sun Simulator



the day of year:

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |

the time of day:

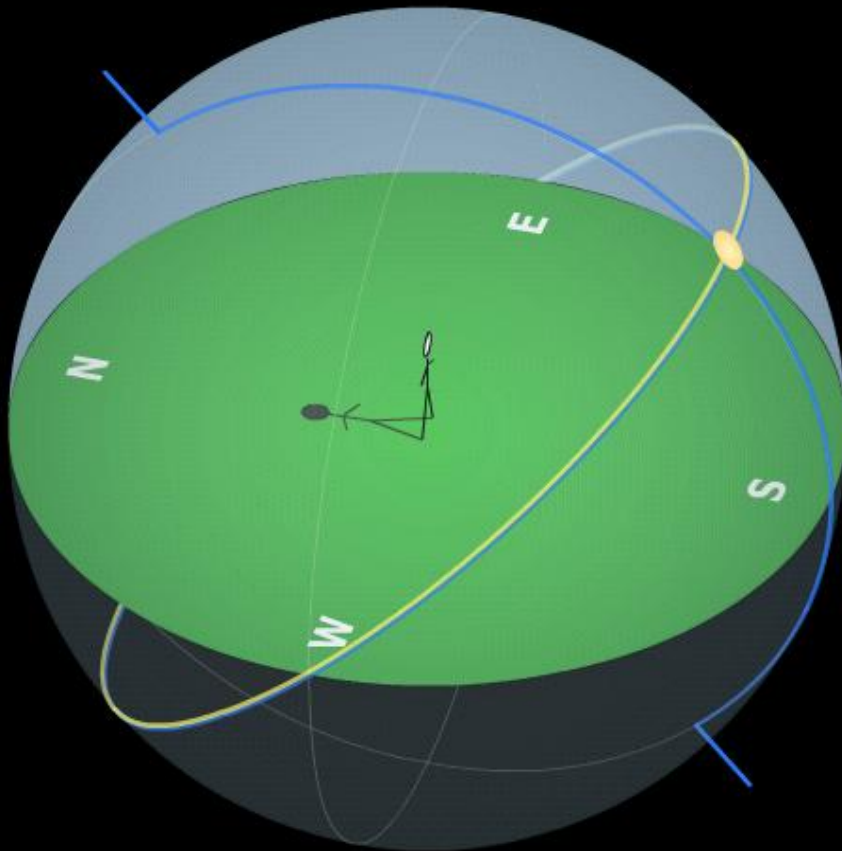


the observer's latitude:



Spring Equinox

Motions of the Sun Simulator



Time and Location Controls

the day of year:

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |

the time of day:

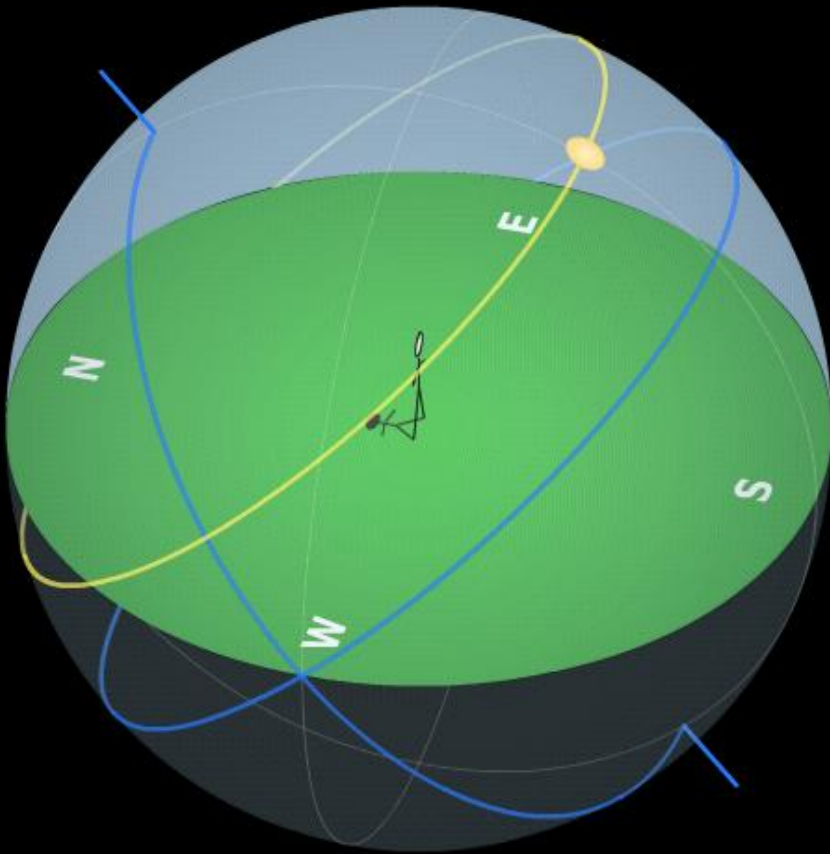


the observer's latitude:



Summer Solstice

Motions of the Sun Simulator



Time and Location Controls

the day of year:

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |

the time of day:

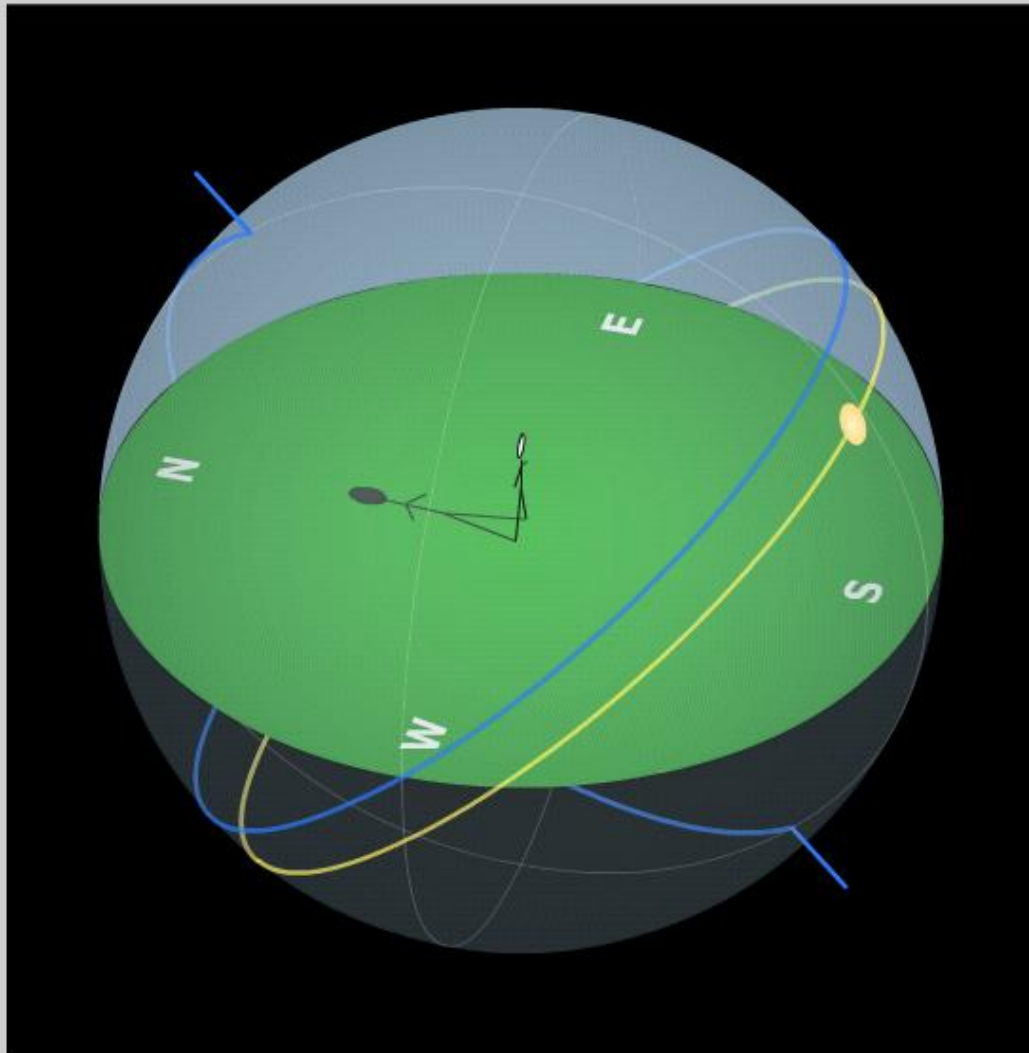


the observer's latitude:



Autumn Day

Motions of the Sun Simulator



Time and Location Controls

the day of year:

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |

the time of day:



the observer's latitude:



Winter Solstice



25. 12. 2001

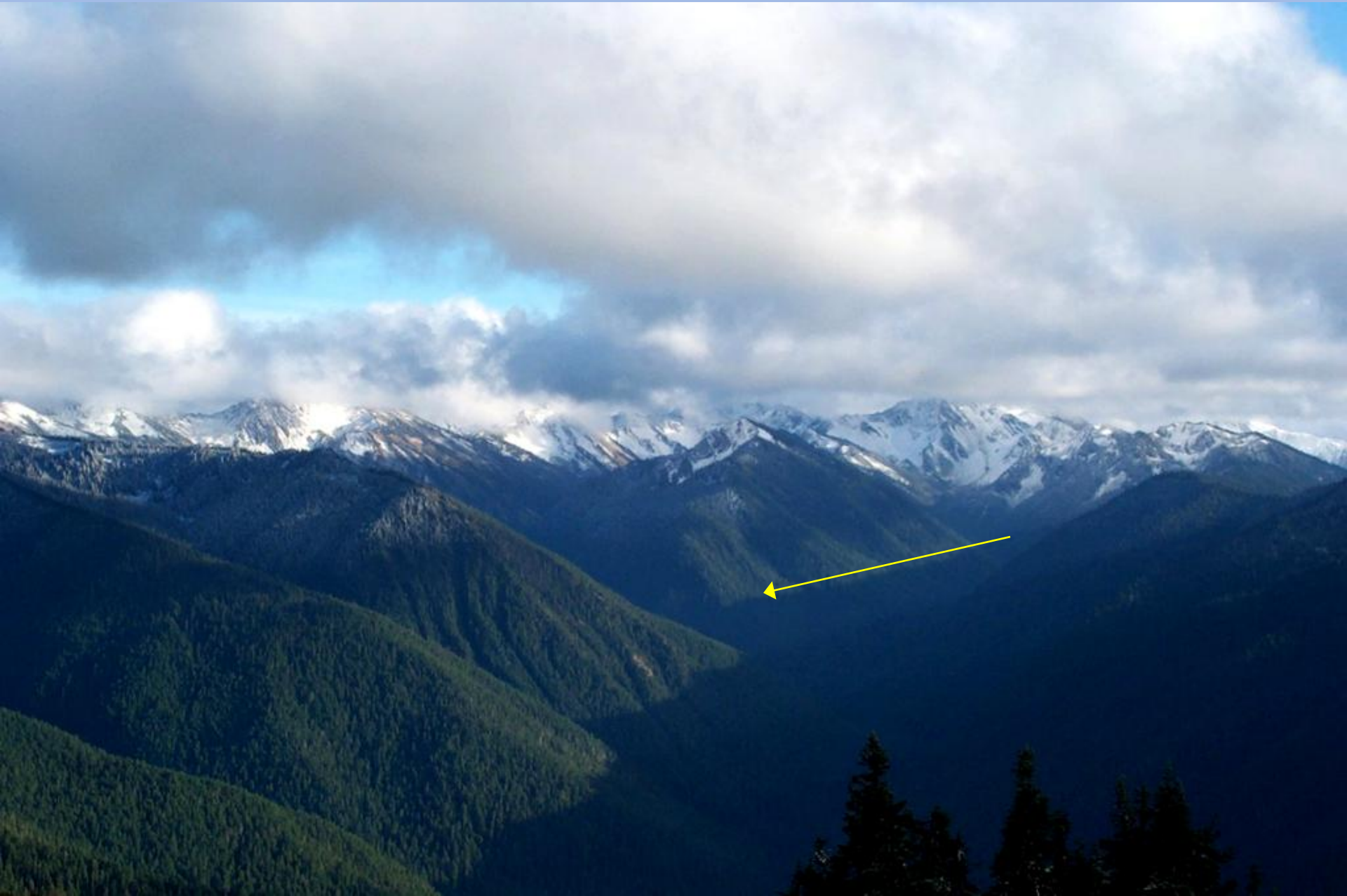
Spring Solstice



Summer Solstice



Autumn Solstice



Thought Questions 1 and 2

- If the Earth did not rotate would there be days and nights?
- If the Earth's axis were not tilted, would there be any seasons?

Thought Questions 1 and 2

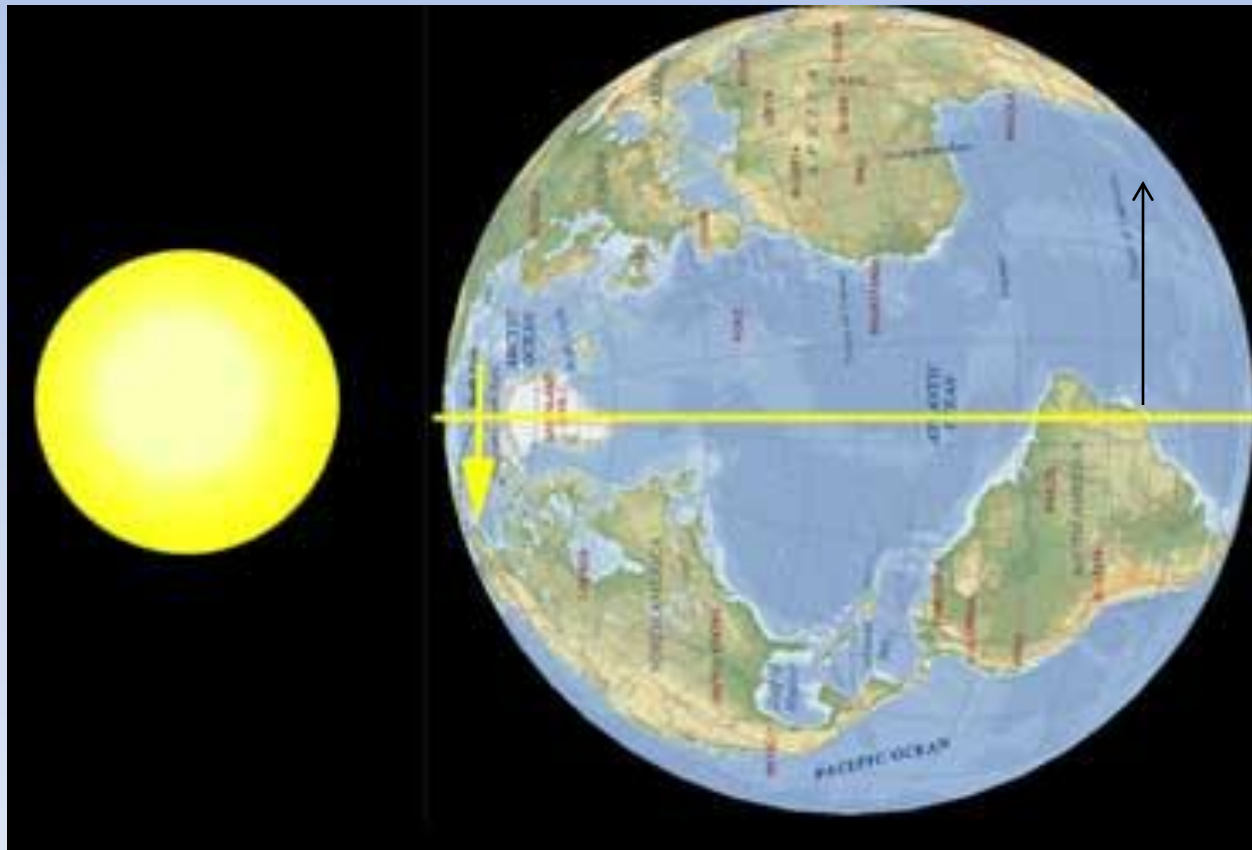
- If the Earth did not rotate would there be days and nights?
- Yes, but a day would last 6 months and a night would last 6 months as the Earth rotates around the sun.

Thought Questions 1 and 2

- If the Earth's axis were not tilted, would there be any seasons?
- No, the equator would be even hotter and the poles would be even colder because there would be no seasonal variation in light.

Homework

- What would the Earth's seasons look like if it were tilted at 90 degrees?



Describe what a year would look like at the north pole, south pole, 45 degrees, and the equator

Content Objectives

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