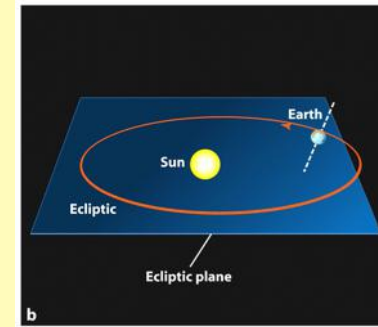


The Seasons

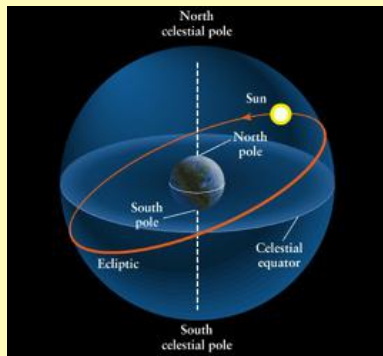


- *ecliptic*: plane of the Earth's orbit around the Sun



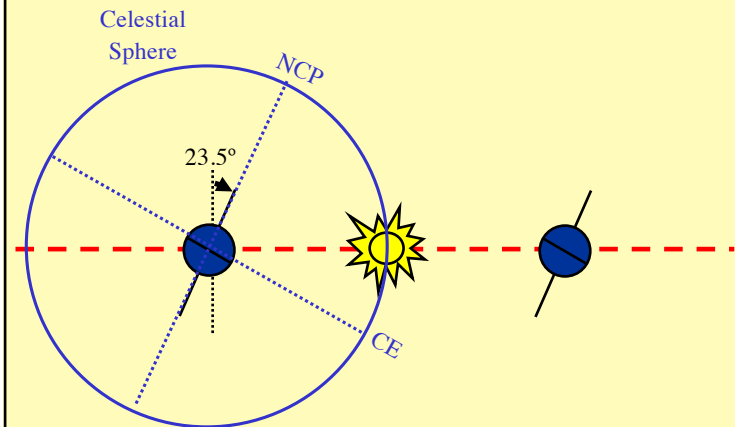
- Earth's *rotational axis* tilted by 23.5° wrt Sun's
- Earth *maintains direction of tilt* as it orbits Sun

- *ecliptic* is *also* the *apparent annual path of the Sun** on the sky (*celestial sphere*)

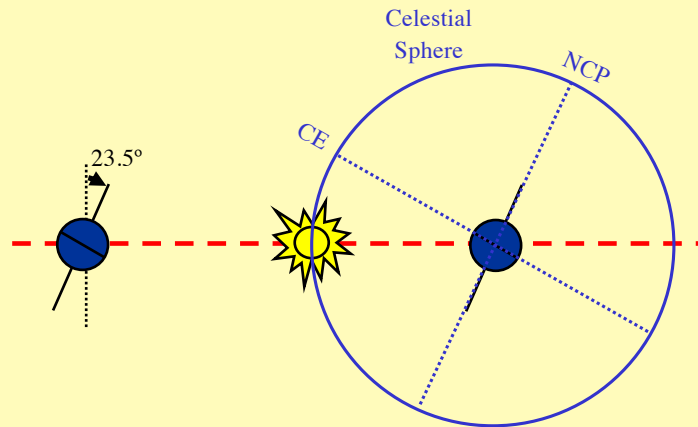


- *not* aligned with *celestial equator* because Earth's *rotational axis* is *tilted* 23.5° from vertical

- Sun appears *above* CE (N. Hemisphere *summer*)



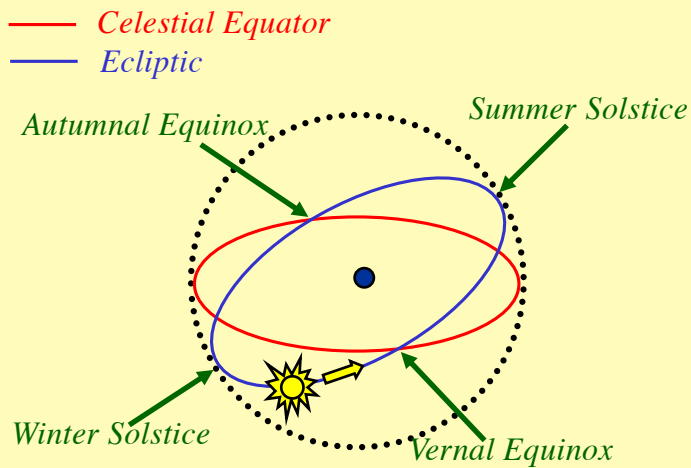
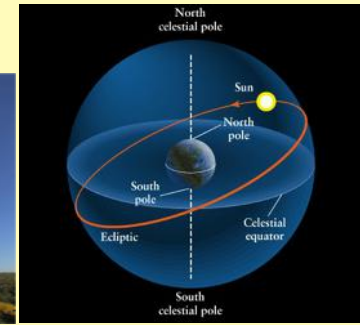
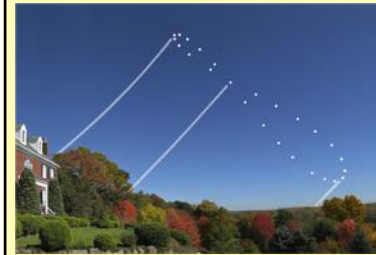
- Sun appears *below* CE (N. Hemisphere *winter*)



- Sun spends *half* the year *above* CE & *half* *below* it
- *solstices*: *highest* & *lowest* points *relative* to CE

Q: What *must* Sun do *between* *solstices*?

- *equinoxes*: points where Sun *crosses* CE



(eg) Solstice "sundial" – position of Sun!

Q: What is the *popular* reason for the seasons?

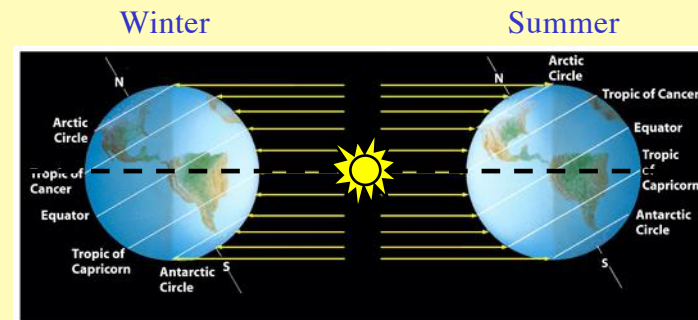
- **not caused** by *distance* of Earth from the Sun!
- *distance* only varies by ~6 million km (**3%**)
- Earth is **closer** to the Sun during our winter!
- **seasons** caused by:
 - **23.5° tilt** of *Earth's rotational axis relative to Sun*
 - *revolution* of Earth around Sun

Q: How does the *tilt* cause the seasons?

- Sun is **higher** (*more overhead*) in the sky
- **solar energy** is more **concentrated** since same **total energy** over **smaller area**: **more heating**



- **longer days** (hence **more heating**) in summer

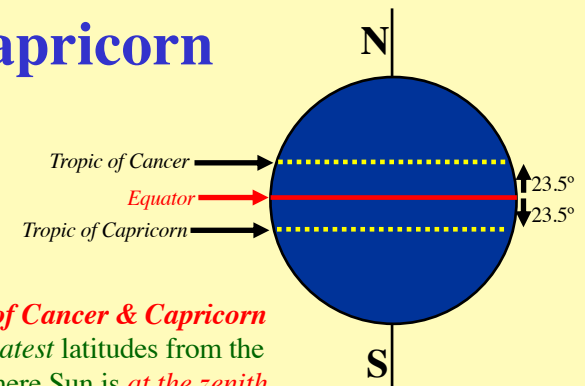


Q: Where is the Sun **overhead** on the *solstices*?

Q: Where is the Sun **overhead** on the *equinoxes*?

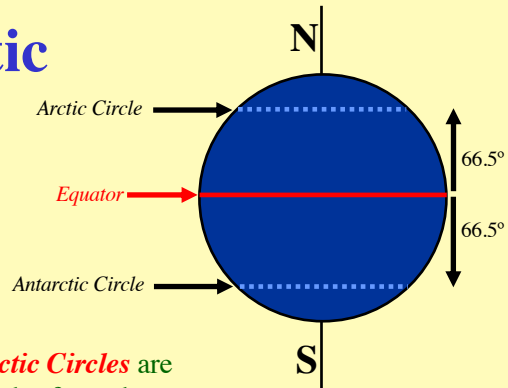
Q: Times & places where Sun **doesn't** rise or set?

Tropics of Cancer & Capricorn

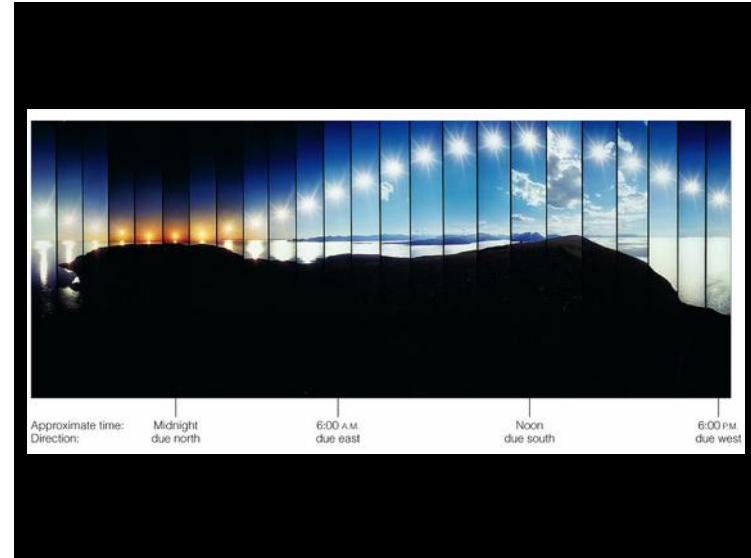


- **Tropics of Cancer & Capricorn** are the **greatest latitudes** from the equator where Sun is **at the zenith** at **some point** during the year

Arctic & Antarctic Circles



- **Arctic & Antarctic Circles** are the *greatest* latitudes from the equator where the Sun rises & sets every day



CLICKER: Where on Earth would you be for the Sun to be at the zenith on the autumnal equinox?

- (a) on the Greenwich meridian
- (b) at the equator
- (c) at the north pole
- (d) at the south pole



CLICKER: You awake on winter solstice & notice that the Sun did not set. Where might you be?

- (a) Antarctica
- (b) Yukon
- (c) Florida
- (d) Ecuador

Q: What if Earth's rotational axis wasn't tilted?

- Sun would always be the *same height in the sky* at a given location on Earth - *no seasons!* (*tropics*)

Q: What if our rotational axis was tilted by 90°?

- *long periods of daylight & darkness!*
- harsh summer & winter seasons
- *extremophiles* rule (*except* about the equator?)