• Ok, so if the Earth weren't tilted, we'd have a picture like the one shown below:
  
  - 12 hours of daylight at all latitudes
  - more insolation in the tropics, less at higher latitudes
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**Conclusion:** The tropics are generally warmer, the higher latitudes are colder
• But of course, if the axis is tilted, then the hemisphere tilted towards the Sun gets more insolation, and the hemisphere tilted away gets less.
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**Conclusion:** The hemisphere tilted towards the Sun is generally warmer, while the hemisphere tilted away is colder.
So what's this have to do with the seasons?
Well, in reality, the Earth's axis is tilted by 23° with respect to the plane of its orbit about the Sun.

So sometimes the NH tilts towards the Sun and sometimes away, depending on its position along the orbit.
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Some key dates:

- **Jun 21, Summer Solstice**: The NH is tilted directly toward the Sun (max NH insolation)

- **Sept 22, Fall Equinox**: Axis tilted neither toward nor away from the Sun (average insolation)

- **Dec 21, Winter Solstice**: The NH is tilted directly away from the Sun (min NH insolation)

- **Mar 20, Spring Equinox**: Axis tilted neither toward nor away from the Sun
Summer Solstice: June 21
Winter Solstice: December 21
Fall Equinox: September 22
Spring Equinox: March 20
So in summary, the seasons are caused by the Earth's tilt and the associated changes in solar insolation throughout the year.
And of course, if we lived in the Southern Hemisphere, everything would be reversed........
So, Mister Professor Dude, you say the max insolation is on the Summer Solstice (Jun 21). But in my world, at least, it's warmer in July and August than in June. So what do you say to that? (Snap.)
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Well, student person, that has to do with seasonal lag.
So, Mister Professor Dude, you say the max insolation is on the Summer Solstice (Jun 21). But in my world, at least, it's warmer in July and August than in June. So what do you say to that? (Snap.)

Well, student person, that has to do with seasonal lag.

(And...scene.)
Seasonal Lag

- Keep in mind that the trend in the temperature (warming vs cooling) is determined by the net radiation budget, not necessarily by the max insolation.

- As long as the incoming shortwave exceeds the outgoing IR, the temperatures will continue to rise.

![Diagram showing incoming solar and outgoing IR radiation with arrows indicating flow through the atmosphere. The situation at the summer solstice is depicted.]
Seasonal Lag

- Keep in mind that the trend in the temperature (warming vs cooling) is determined by the net radiation budget, not necessarily by the max insolation
  - As long as the incoming shortwave exceeds the outgoing IR, the temperatures will continue to rise
- And the incoming shortwave exceeds the outgoing IR for at least several weeks past the summer solstice
  - Ergo, the warmest temperatures will be in July and August
Seasonal Lag

- But....as we go past the solstice, two things start to happen:
Seasonal Lag

• But....as we go past the solstice, two things start to happen:
  1) temperatures rise, so the outgoing IR increases
  2) the incoming solar radiation decreases
But...as we go past the solstice, two things start to happen:

1) temperatures rise, so the outgoing IR increases
2) the incoming solar radiation decreases

So eventually the two trends will cross (so that IR exceeds solar) and the temperatures will start to decrease

Seasonal Lag

situation in late August