Chapter 4

Global Climates and Biomes

Earth's Atmosphere:

1. **Troposphere-** the layer closest to Earth's surface extending roughly 16 km (10 miles) above Earth. (*weather*)

2. **Stratosphere-** above the troposphere, this extends from roughly 16 to 50 km (10-31 miles, less dense than trop, higher pressure). Ozone layer is here (O_3) – absorbs most of the Sun's UV radiation.

3. **Mesosphere**

4. **Thermosphere –** ability to block harmful X-ray & UV radiation. Contains gas molecules that when hit with solar energy, begin to glow & produce light (Northern Lights)

5. **Exosphere**

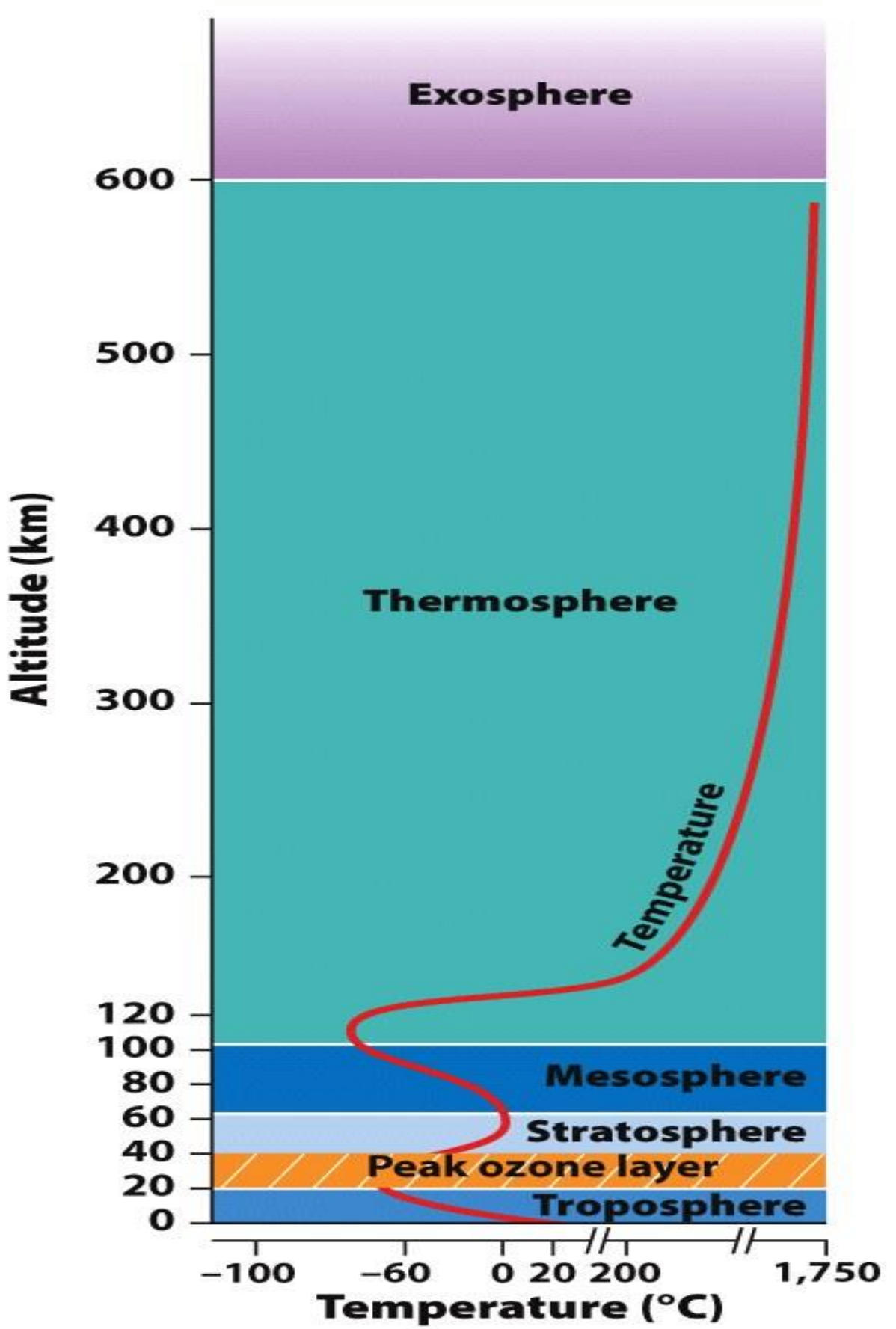

Figure 4.1
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Global Processes Determine Weather and Climate

Regional differences in temp & precipitation collectively help determine which organism can survive,

Processes that affect this are…

1. Unequal heating of Earth's by Sun,

2. atmospheric convection currents,

3. rotation of Earth,

4. orbit around the Sun,

5. Ocean currents

1. Unequal Heating of Earth

- As the Sun's energy passes through the atmosphere and strikes land and water, it warms the surface of Earth. But this warming does not occur evenly across the planet.

(Ex). In the stratosphere, UV radiation reaches higher altitudes first and warms them, the higher altitudes are warmer than lower.

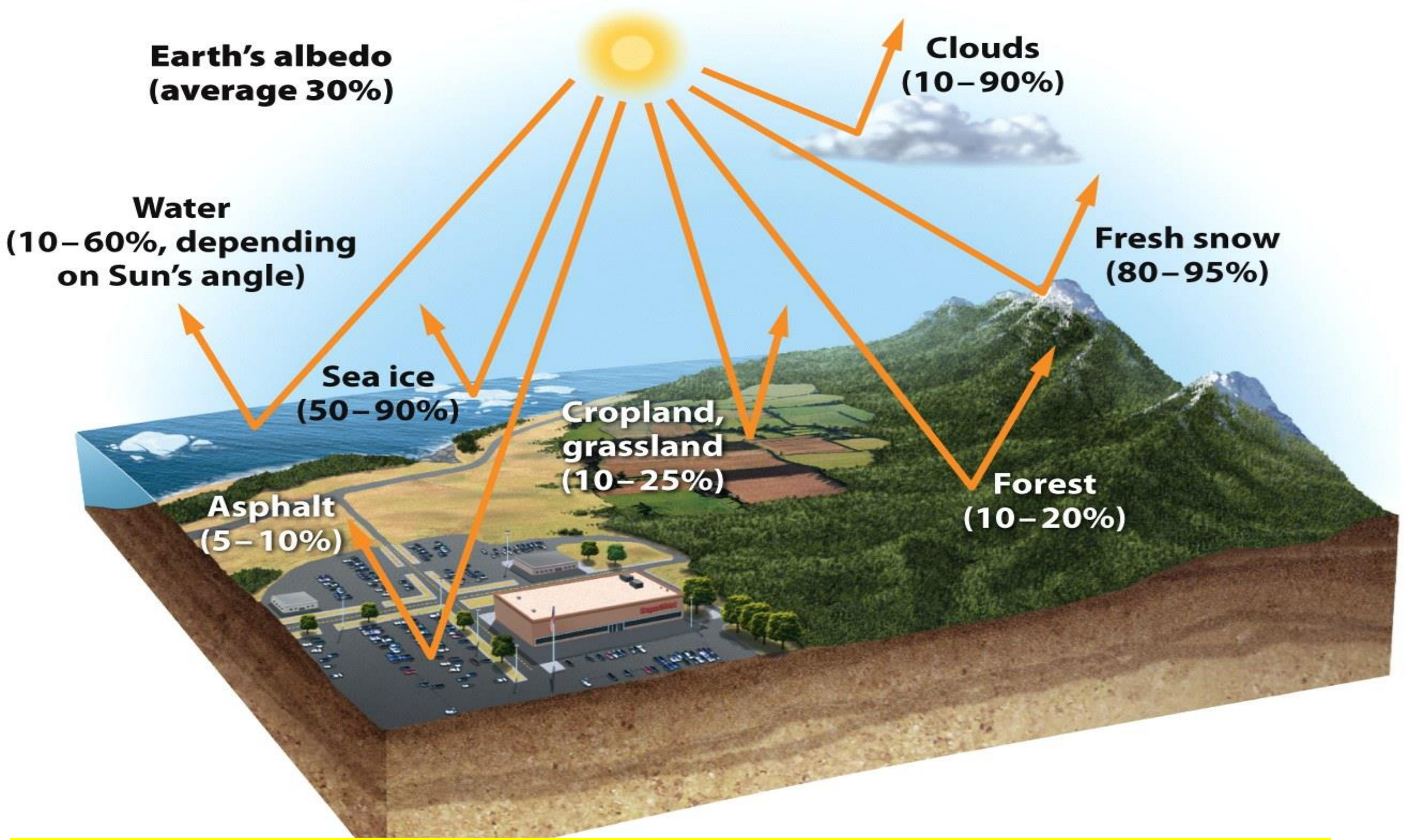
<u>3 Primary causes of uneven warming patterns</u>:

1. The variation in angle at which the Sun's rays strike (oblique angles vs right– near equator, travel shorter)

2. The amount of surface area over which the Sun's rays are distributed – based on the angle, regions may receive more solar energy per square meter (tropics)

3. Some areas of Earth reflect more solar energy than others. (*Albedo Effect*)

Albedo effect – percentage of the incoming solar energy that is reflected



Higher the albedo of a surface, more energy is reflect = less is absorbed

White (higher albedo) vs. black surfaces

2. Atmospheric Convection Currents

Air has four properties that determines its movement due to unequal heating of Earth:

1. **Density-** less dense air rises, denser air sinks.

2. **Water vapor capacity-** warm air has a higher capacity for water vapor than cold air. ***(saturation point – when temps fall, so does the s. point, vapor condenses and rains/snows)***

3. **Adiabatic heating or cooling-** as air rises in the atmosphere the pressure acting on it decreases (particles) and the rising air expands *(less collisions)* in volume (Adiabatic cooling of the air). As air sinks toward Earth, the pressure on it increases and the air decreases in volume due to higher pressure forces (heating).

4. Latent heat release- when water vapor in the atmosphere condenses into liquid water and energy is released.

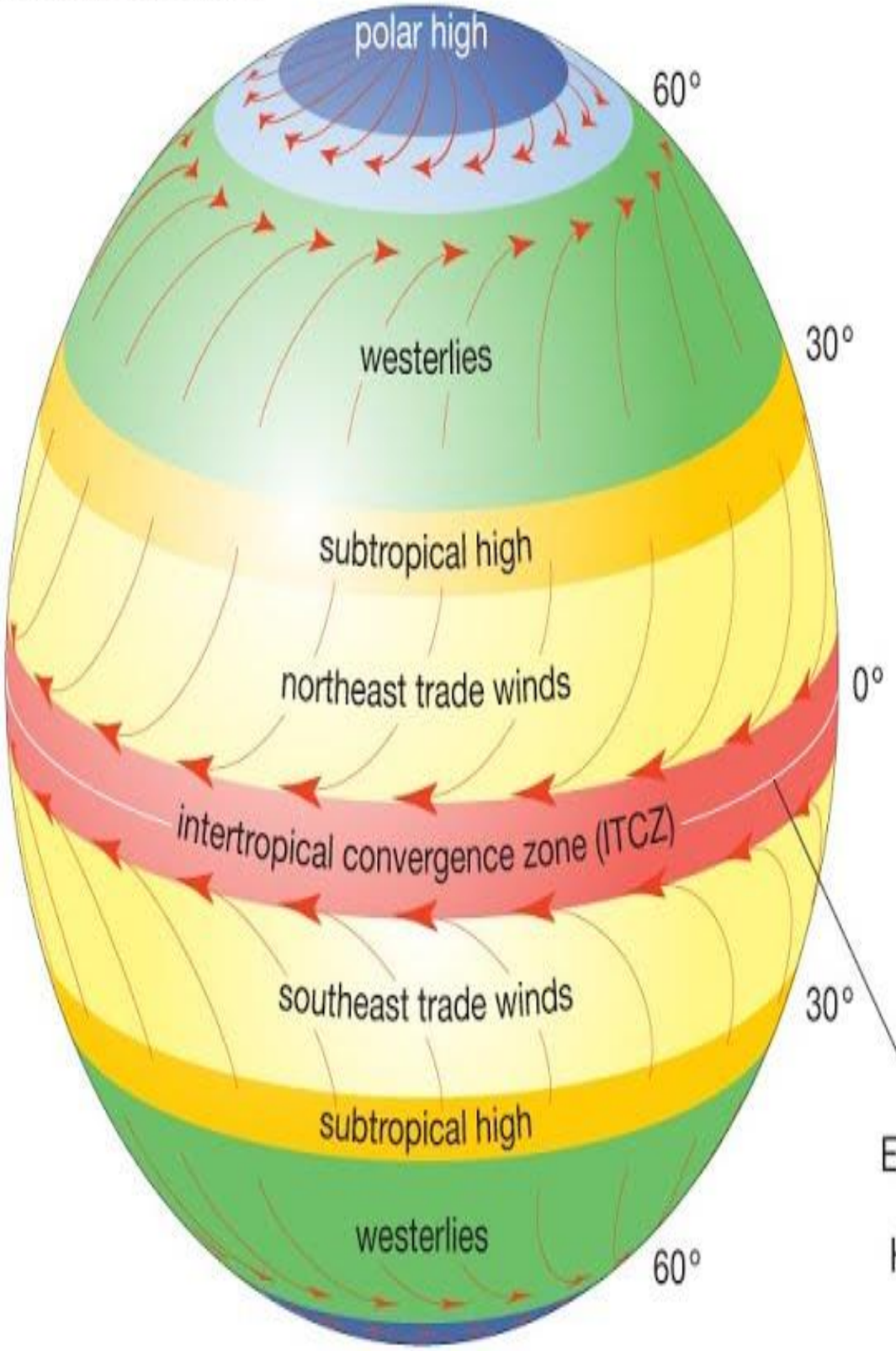
Formation of Convection Currents (move air around Earth w/o considering rotation on axis)

- Atmospheric convection currents are global patterns of air movement that are initiated by the unequal heating of Earth.

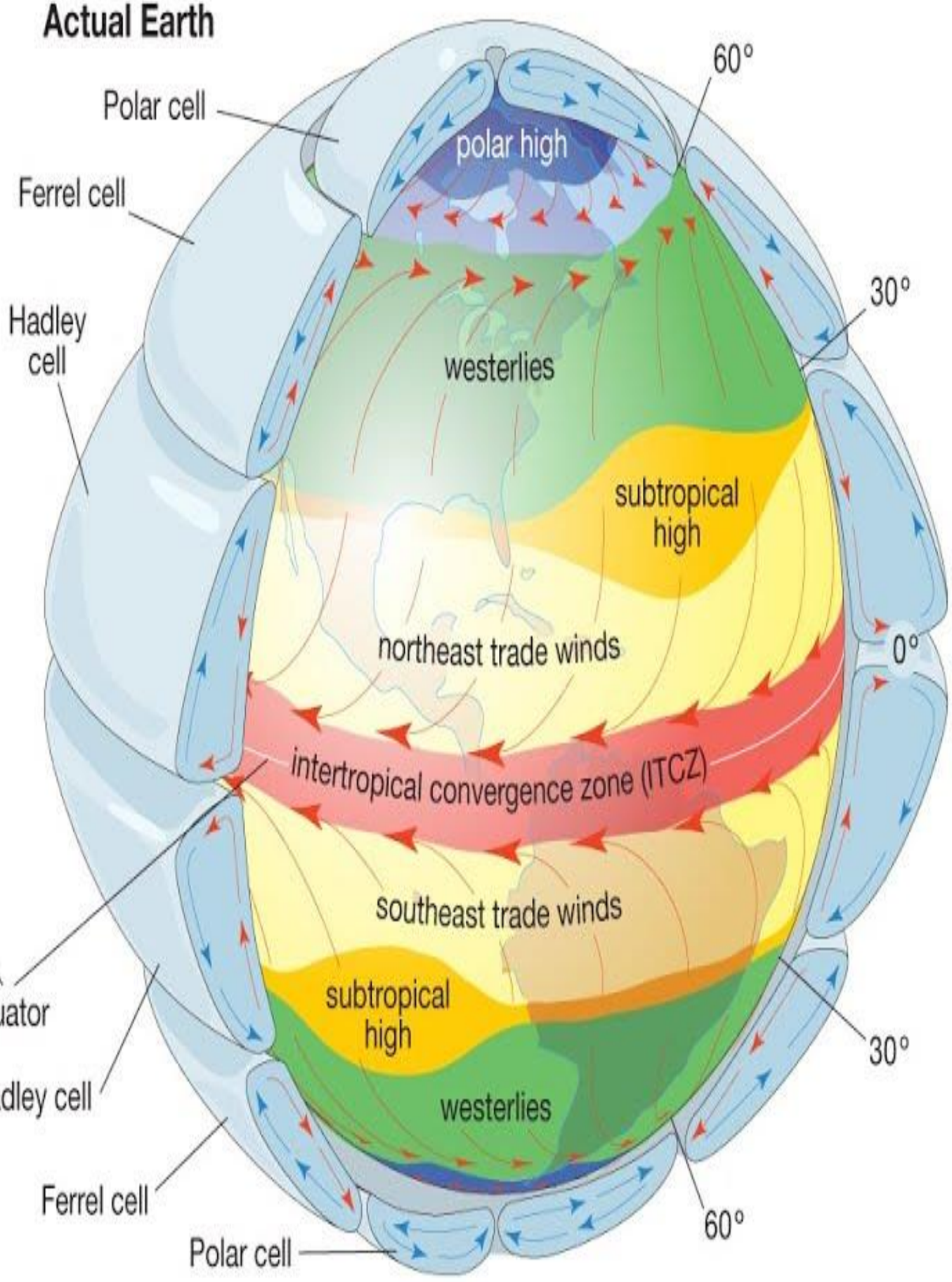
- Ex. In the tropics, warming of humid air, decrease in density…air begins to rise causing lower pressure (adiabatic cooling), cooling causes condensation allowing formation of clouds and precipitation (look at figure 4.6).

- **Intertropical convergence zone (ITCZ)-** the area of Earth that receives the most intense sunlight and where the ascending branches of the two Hadley cells converge (locations not fixed, based on Earth's rotations)

Idealized Earth



Actual Earth



Formation of (Hadley cells) Convection Currents

- Hadley cells- the convection currents that cycle between the equator and 30˚ north and south.
- Intertropical convergence zone (ITCZ)
- Refer to the figure...
- And Video

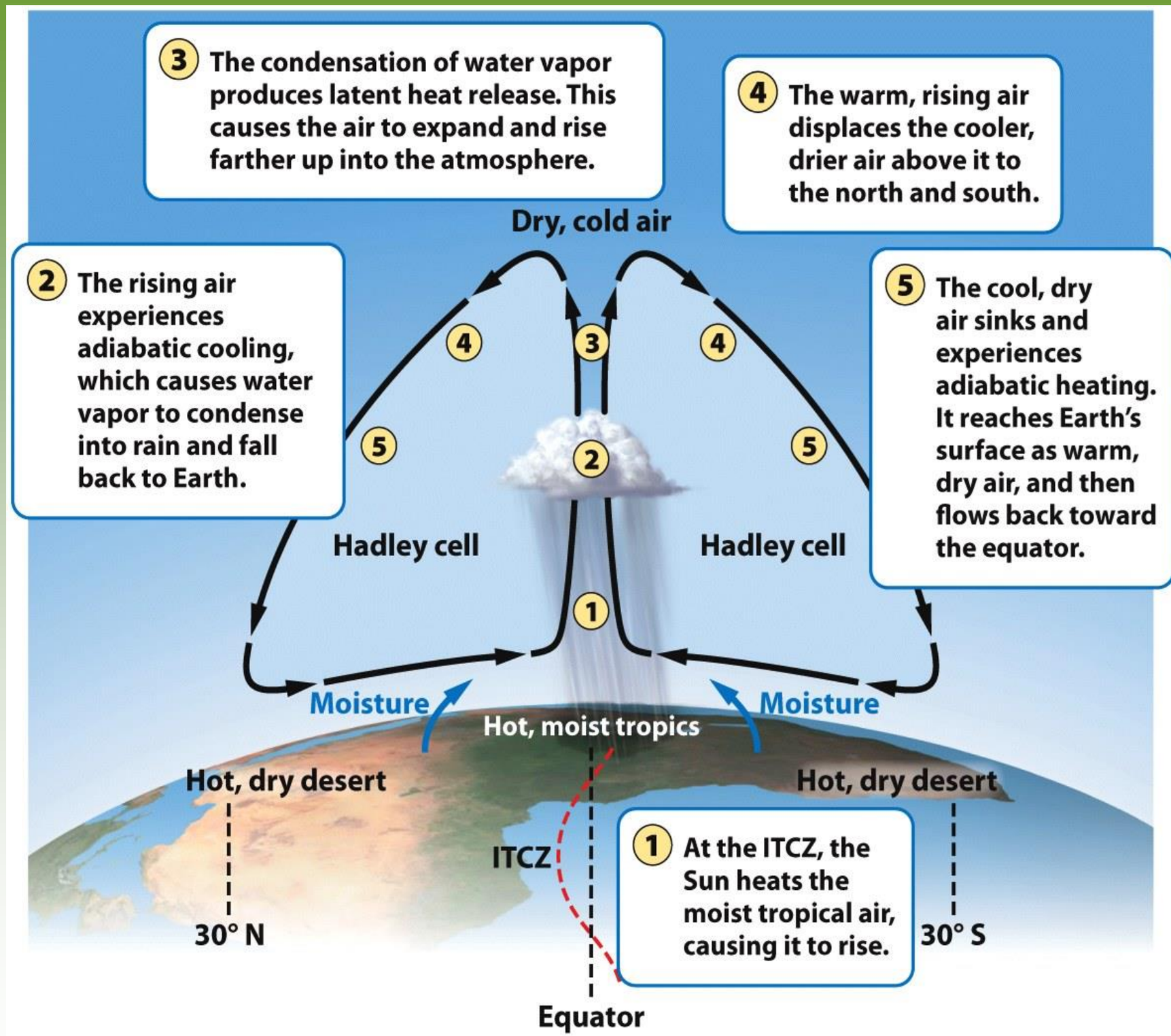


Figure 4.6
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3. Earth's Rotation and the Coriolis Effect

- Similar to Hadley cells, **Polar cells**- the convection currents that are formed by air that rises at 60˚ north and south and sinks at the poles (90˚ north and south)

- Btwn Hadley and Polar cells, a third circulation (Ferrell cell) can form. **Does not form distinct convection cells but is driven by the circulation of the neighboring cells.**

- This movement not only helps to distribute warm air away from the tropics and cold air away from the poles, but also allows a wide range of warm & cold air currents to circulate btwn 30* & 60*.

- Due to the Coriolis Effect, air movement toward the equator is deflected to the WEST.

- Hadley cells cause north of the equator to produce winds along the Earth's surface come from the northeast (northeast trade winds)

- Cell south of the equator, produces wind that comes from the southeast (southeast trade winds)

- If Earth did not rotate, air w/in convection cell would simply move directly North & South and cycle back again.

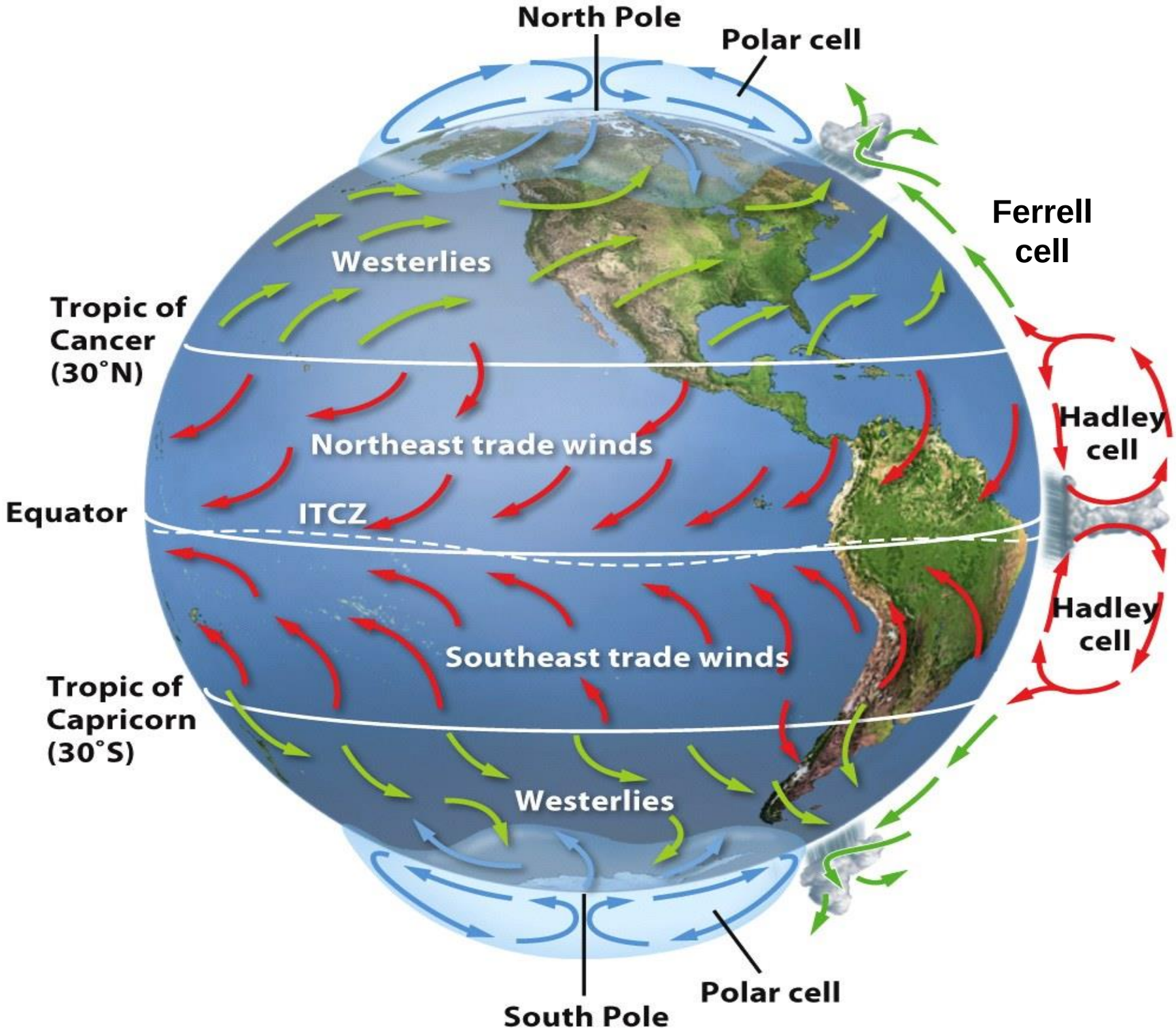

Figure 4.9
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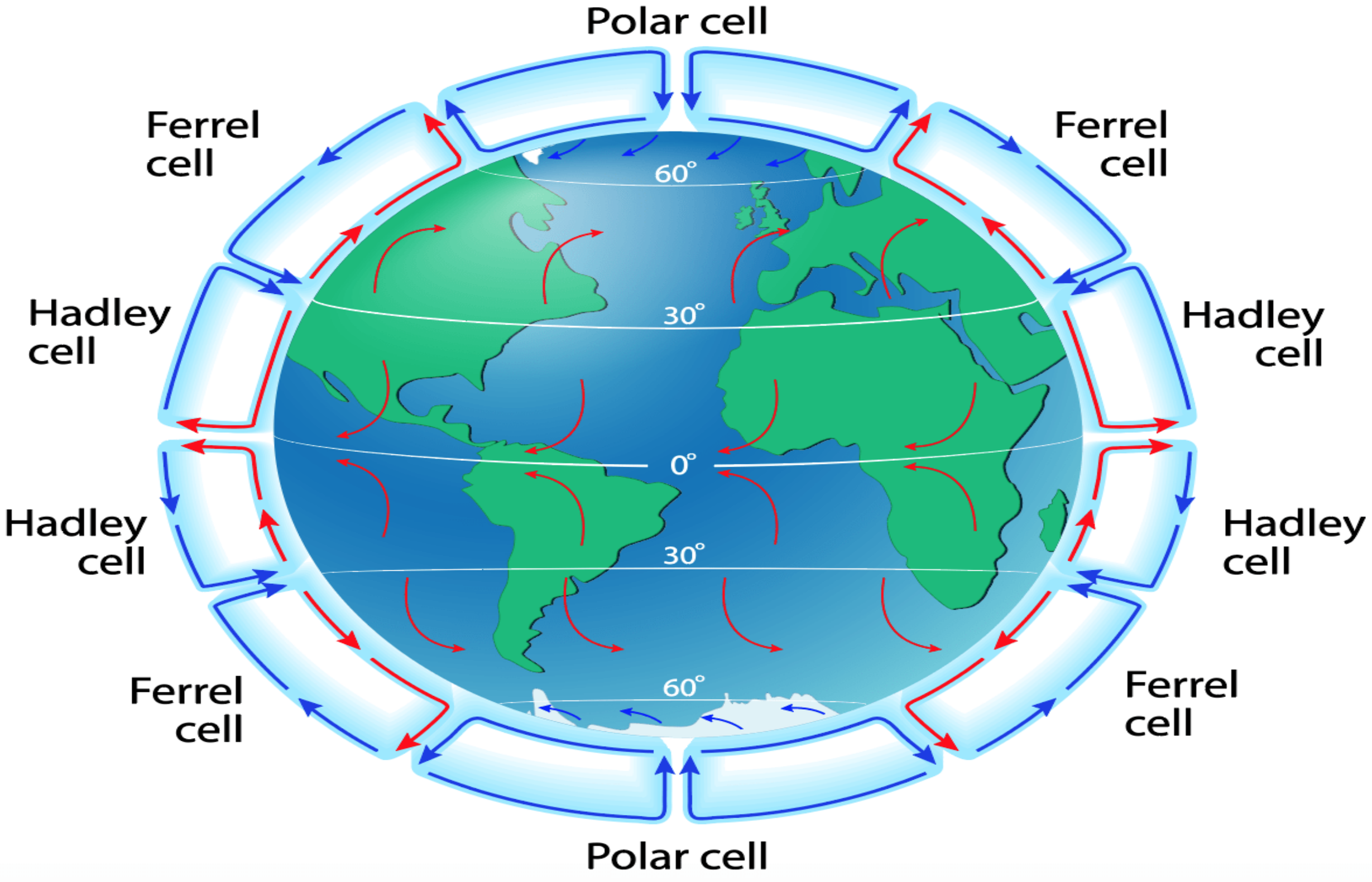
The prevailing **winds** of the world are produced by a combination of atmospheric convection currents (Hadley-ITCZ, Polar cells & Ferrell cells btwn Hadley & polar) and the Coriolis effect.

GLOBAL ATMOSPHERIC CIRCULATION



4. Orbit around the Sun...

The Earth's axis of rotation is tilted 23.5 °.

- The latitude that receives the most direct rays of the Sun and the most hours of daylight changes throughout the year as Earth rotates around the Sun **(season changes)**

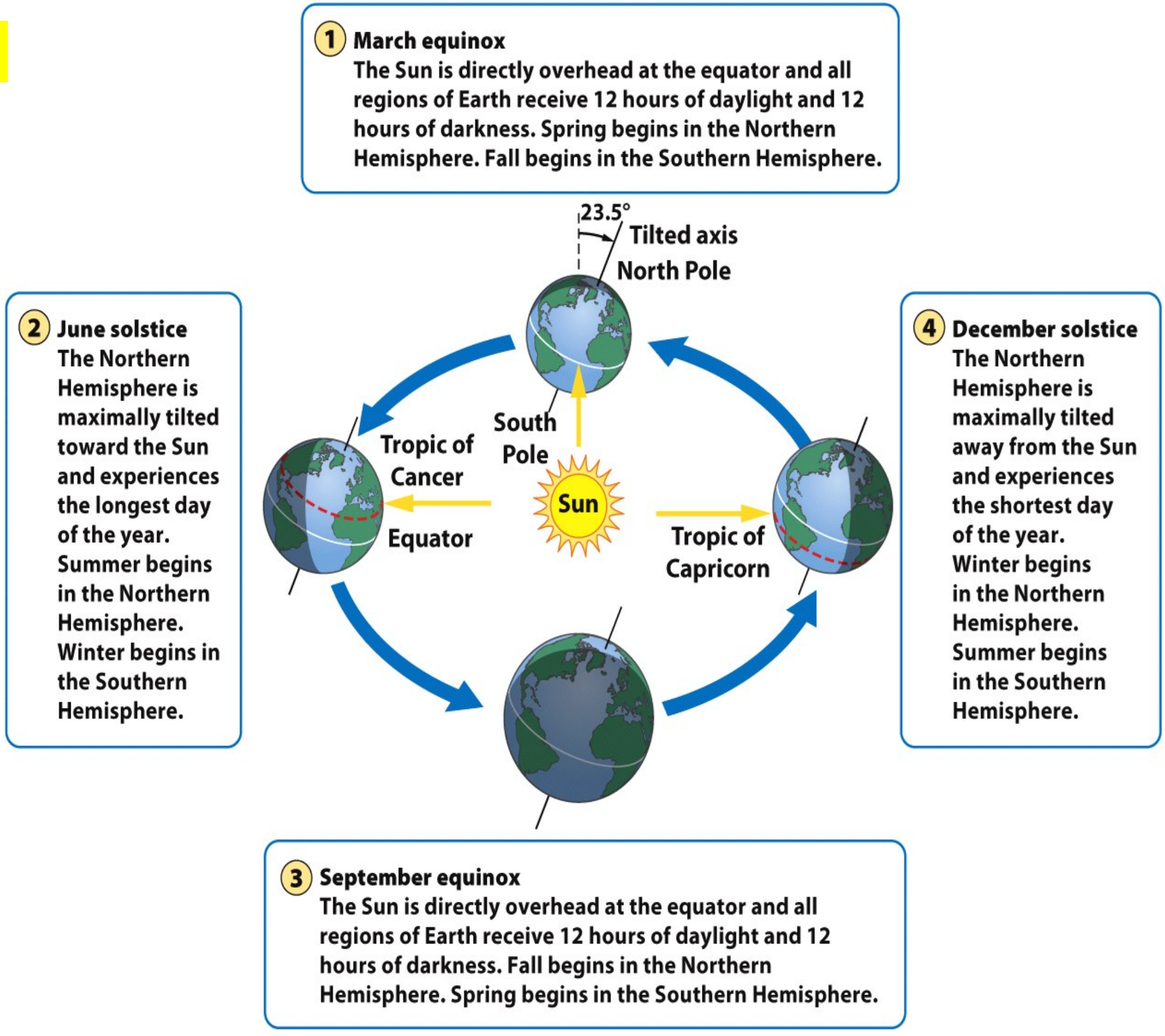


Figure 4.10
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SEASON CHANGES DUE TO LOCATION AND ROTATION

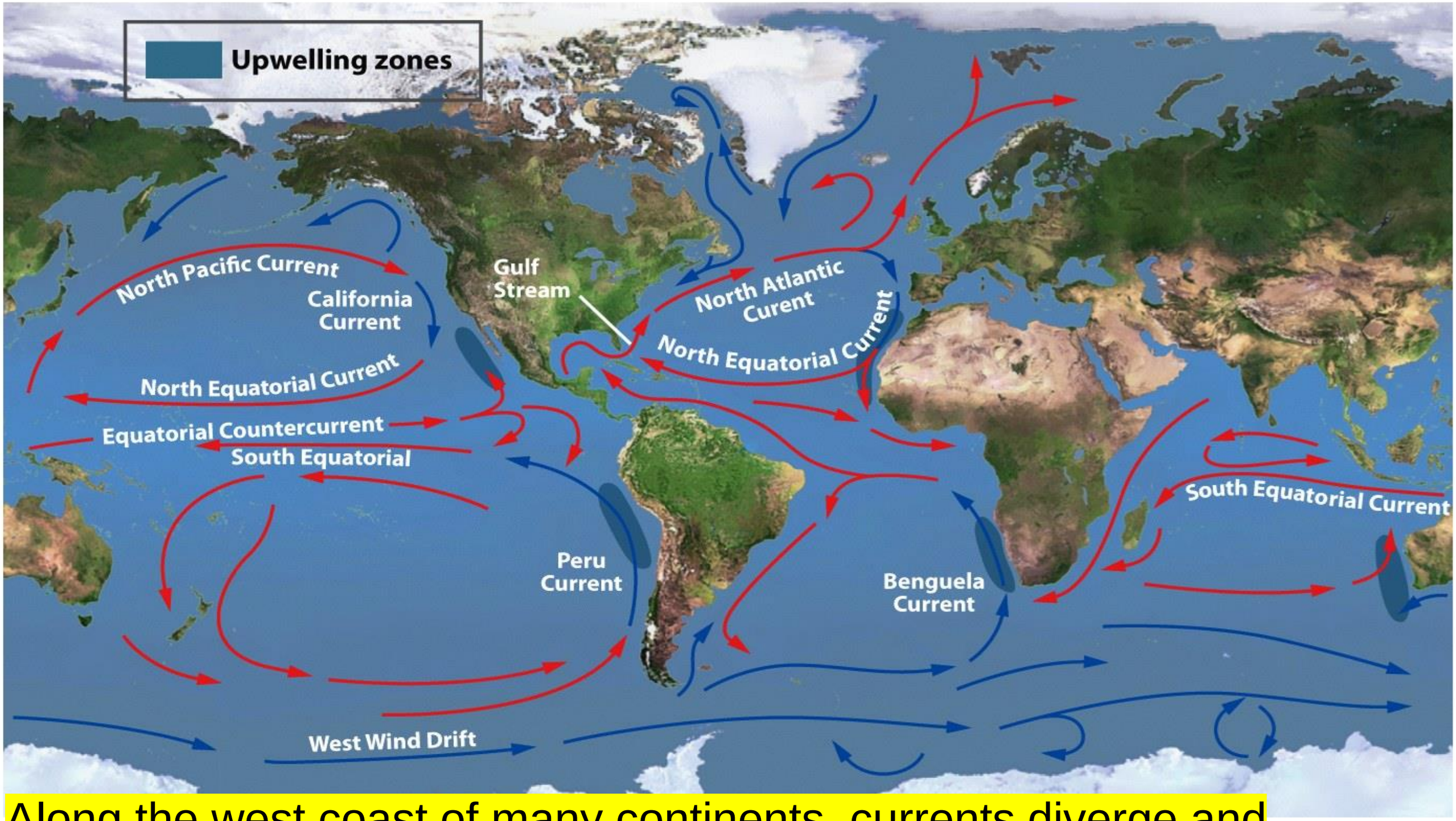
5. Ocean Currents

- **Ocean currents** are driven by a combination of temperature, salt, gravity, prevailing winds, the Coriolis effect, and the locations of continents.

- Warm water, like warm air, expands and rises.

- **Gyres-** the large-scale patterns of water circulation. The ocean surface currents rotate in a clockwise direction in the Northern Hemisphere and a counterclockwise direction in the Southern Hemisphere.

Oceanic Circulation Patterns – clockwise circulation in Northern Hemisphere & counterclockwise circulation in the Southern Hemisphere. Temp in water



Along the west coast of many continents, currents diverge and cause upwelling(deeper water rises) of deeper more fertile water

El Nino-Southern Oscillation

(warm phase)

- Every 3 to 7 years, the interaction of the Earth's atmosphere and ocean cause surface currents in the tropical Pacific Ocean to REVERSE direction.

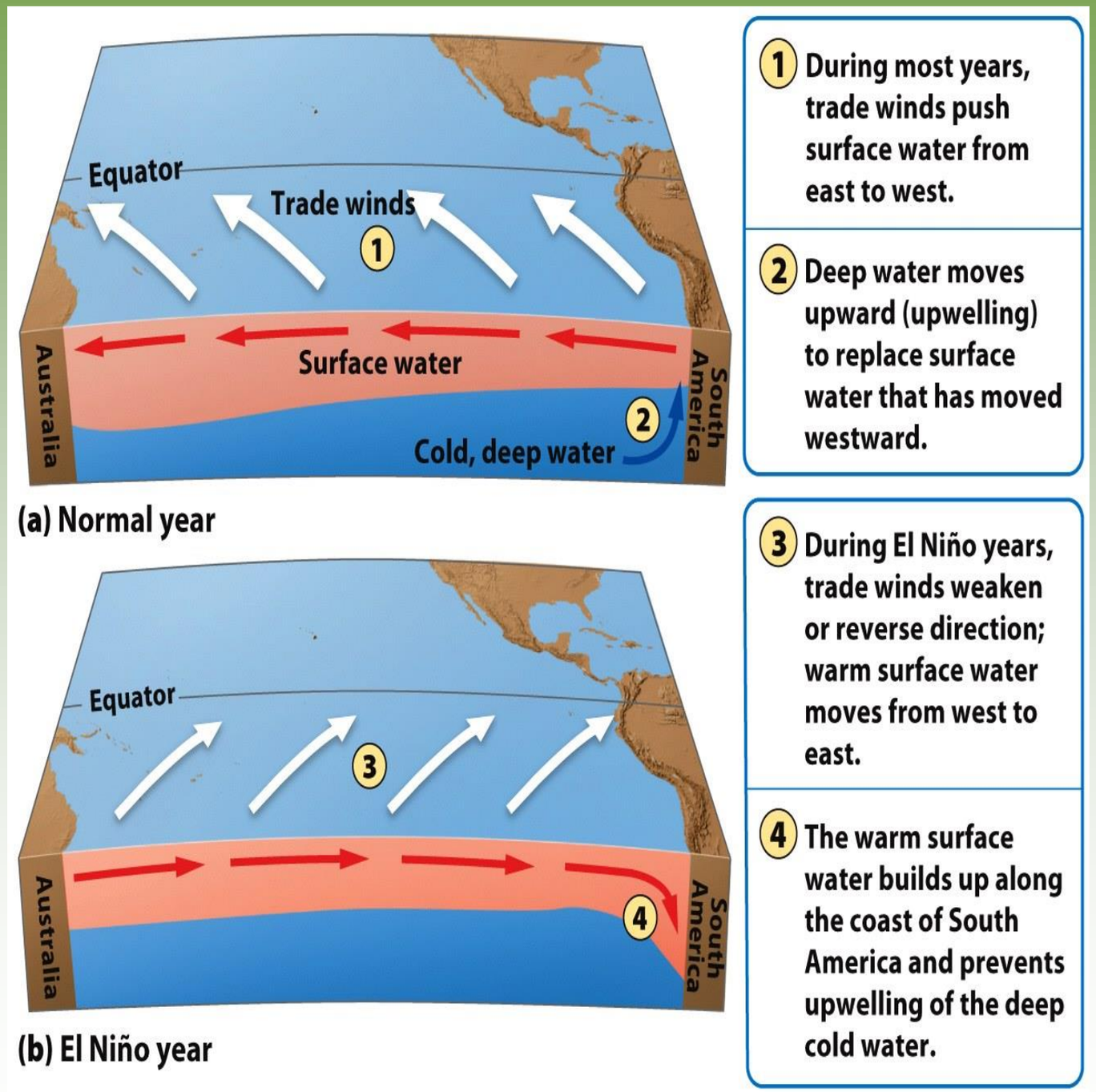


Figure 4.13
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El Nino-Southern Oscillation

- First, the *trade winds* *near South America* *weaken*.
- This weakening allows warm equatorial water from the western Pacific to move eastward toward the west coast of South America.
- The movement of warm water and air toward South America **suppresses upwelling** off the coast of Peru and **decreases productivity** there, reducing fish populations near the coast.
- These periodic changes in wind and ocean currents are collectively called the **EL Nino-Southern Oscillation, or ENSO**.
- **Globally, the impact of ENSO includes cooler and wetter conditions in the southeastern U.S.**

La Nina- (cool phase)

- Trade winds that blow west across the Tropical Pacific are STRONGER than normal.

- Increase in the upwelling off of South America

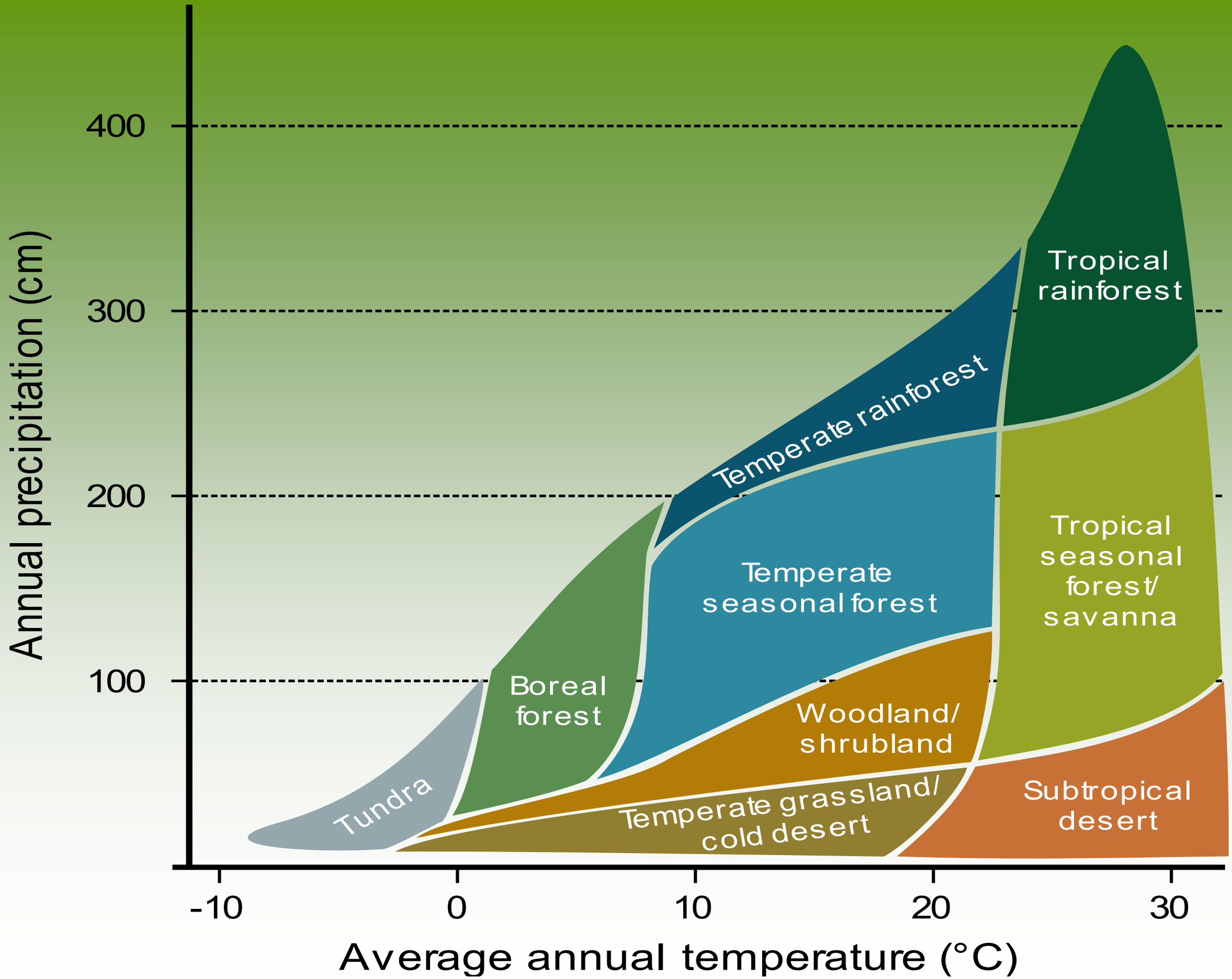
- Resulting in cooler-than-normal conditions across the Pacific northwest, and drier-and warmer-than-normal conditions in southern U.S…..increased number of Hurricanes and monsoons in India and Asia

- Winter temps are warmer than normal in southern U.S and cooler in northwest

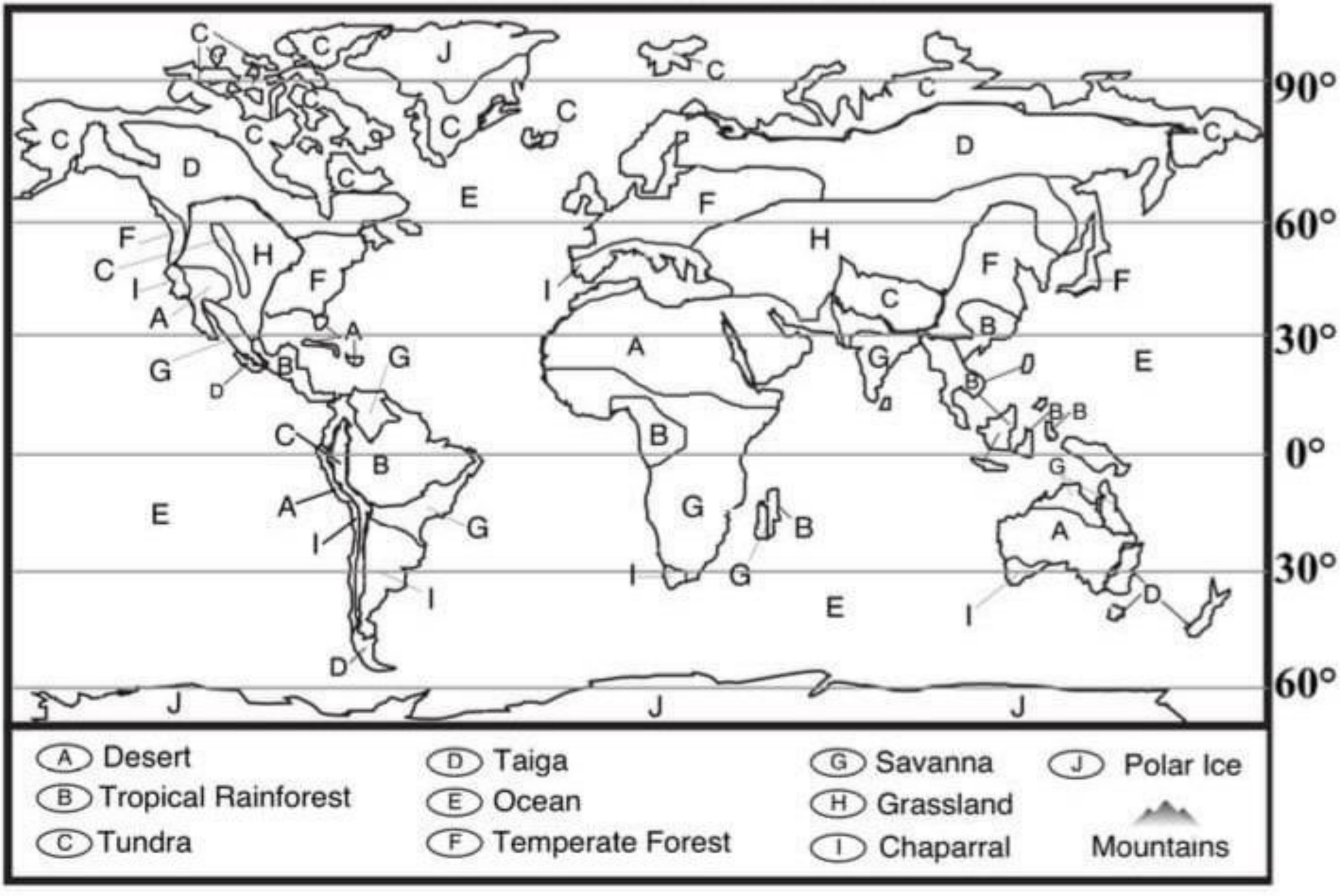
What are El Niño and La Niña?

Variations in Climate Determine the Dominant Plant Growth Forms of **Terrestrial Biomes** *(categorized by plant growth forms)*

- Climate affects the distribution of species around the globe.
- Organisms possess distinct growth forms due to **adaptations to local temperature and precipitation patterns.**
- **Biomes-** The presence of similar plant growth forms in areas possessing similar temperature and precipitation patterns.


Annual precipitation (cm)
400
300
200
100
Tropical rainforest
Temperate rainforest
Tropical seasonal forest/ savanna
Temperate seasonal forest
Boreal forest
Woodland/ shrubland
Tundra
Temperate grassland/ cold desert
Subtropical desert
-10
0
10
20
30
Average annual temperature (°C)

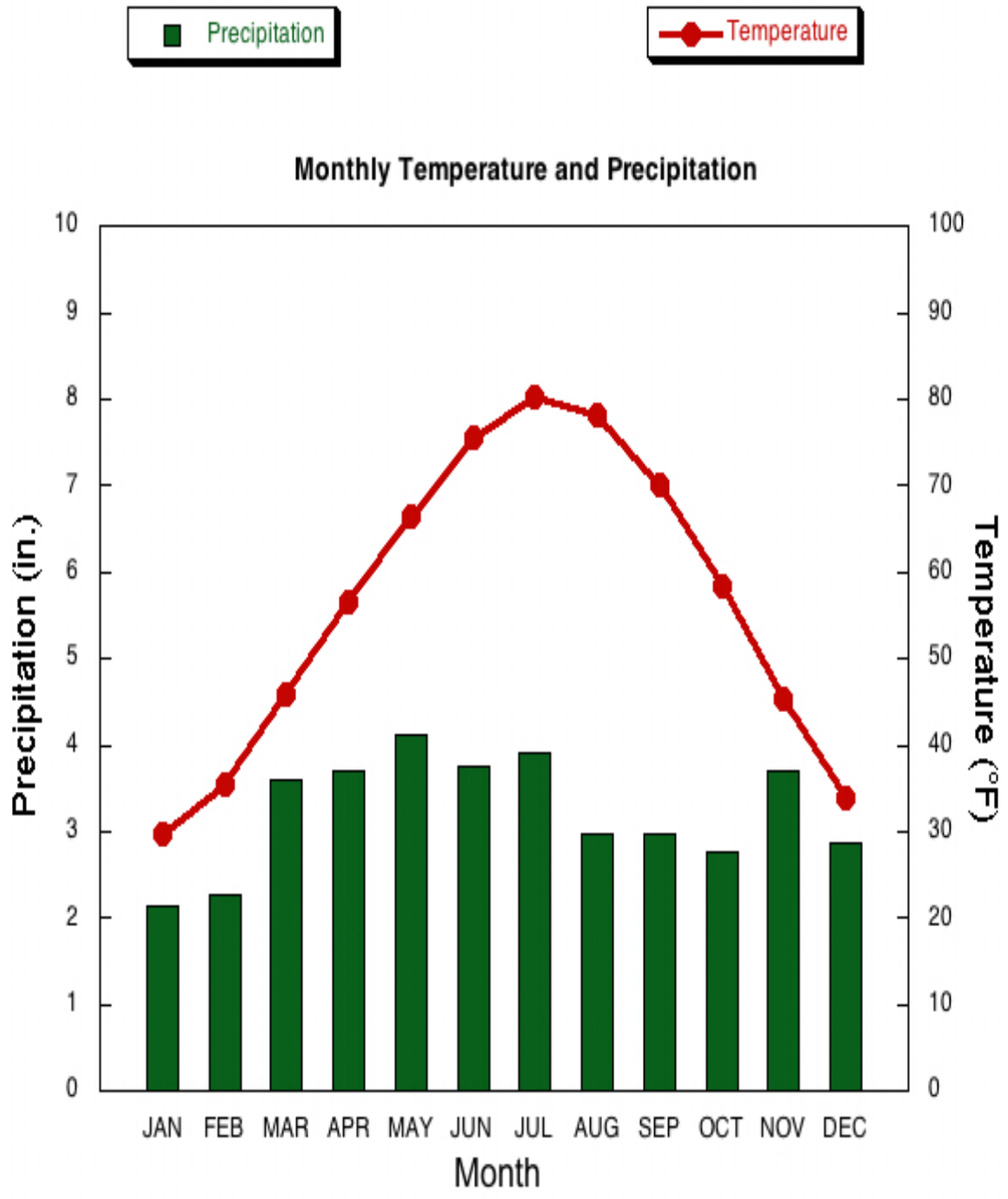
Biome World Map

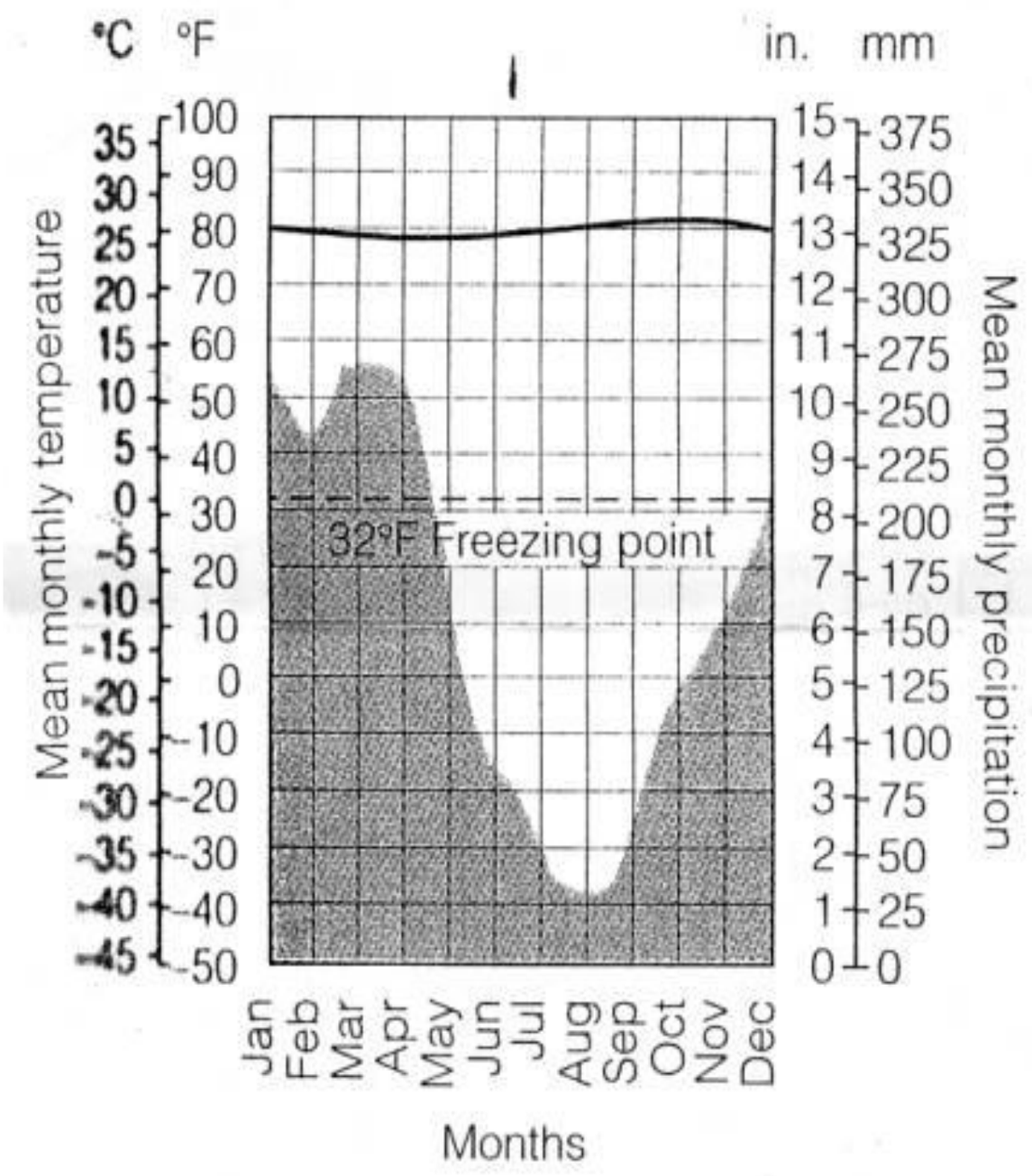


Climograph (Climate-graph)

A quick way to get an idea of the climate of a particular place

A climograph is what scientists create to show a particular location's average temperature and precipitation during the year.



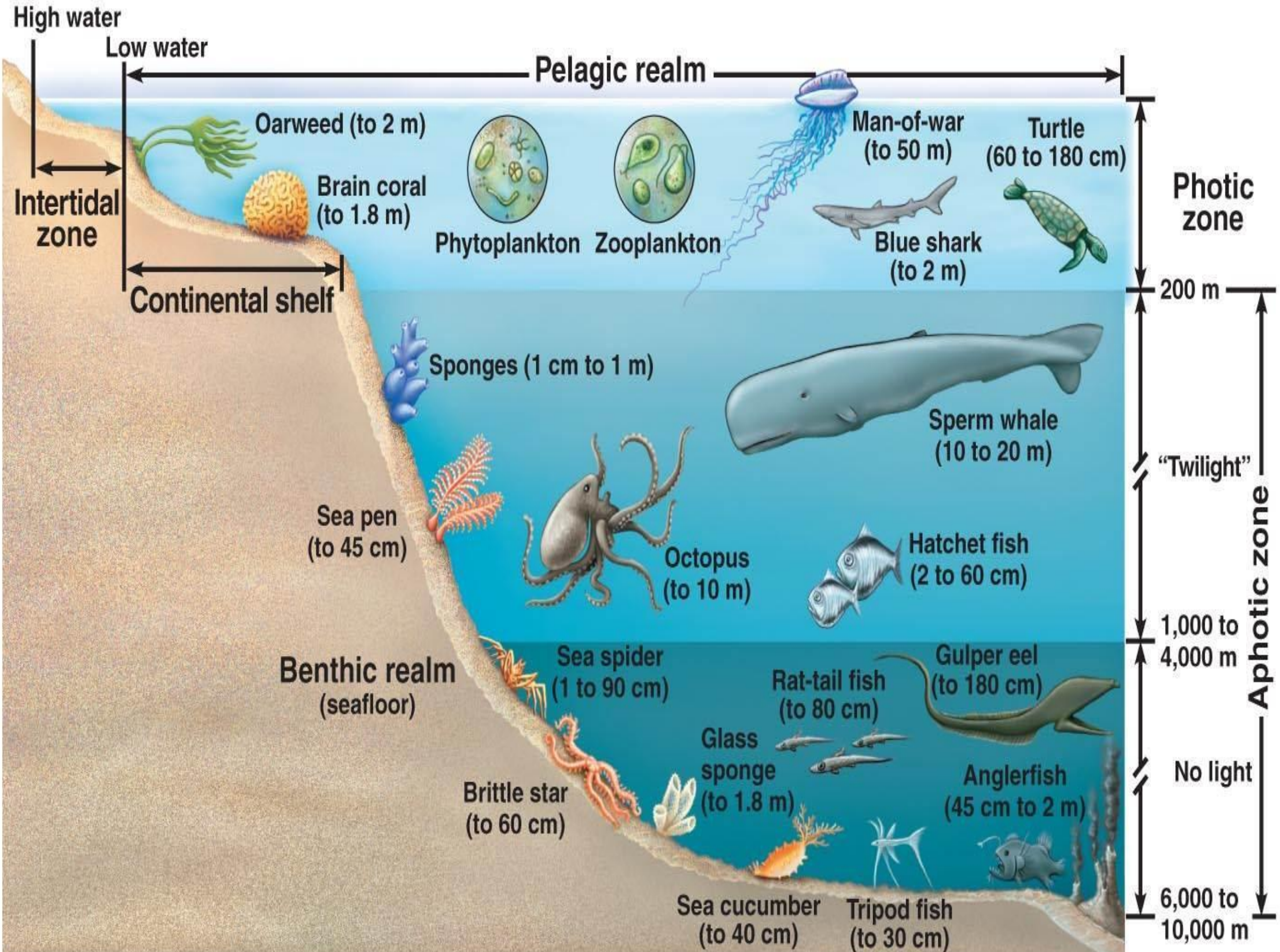


Aquatic Biomes are Categorized by *Salinity, Depth, and Water Flow*

Two Broad categorize:

1. **Fresh water** – streams, rivers, lakes, wetlands
2. **Marine (salt) water** – shallow marine areas, estuaries, coral reefs (open oceans)

Temp determines what species can survive in a particular aquatic habitat (not used to categorize)


High water
Low water
Pelagic realm
Oarweed (to 2 m)
Brain coral (to 1.8 m)
Intertidal zone
Continental shelf
Phytoplankton
Zooplankton
Man-of-war (to 50 m)
Turtle (60 to 180 cm)
Blue shark (to 2 m)
Photic zone
200 m
Sponges (1 cm to 1 m)
Sperm whale (10 to 20 m)
"Twilight"
Sea pen (to 45 cm)
Octopus (to 10 m)
Hatchet fish (2 to 60 cm)
Aphotic zone
1,000 to 4,000 m
Benthic realm (seafloor)
Sea spider (1 to 90 cm)
Rat-tail fish (to 80 cm)
Gulper eel (to 180 cm)
Glass sponge (to 1.8 m)
Brittle star (to 60 cm)
Anglerfish (45 cm to 2 m)
No light
Sea cucumber (to 40 cm)
Tripod fish (to 30 cm)
6,000 to 10,000 m

- Regional variations in global climate of aquatic and terrestrial biomes, have a major effect of on the types of organisms that can live in different parts of the world.

- **Terrestrial biome**, temp and precipitation affect the rate of decomposition and the productivity of the soil.

- **Aquatic biomes**, differences in water flow, depth, and salinity describes why certain species live in certain regions of the world.