SFU CO-OPERATIVE EDUCATION

SCIENCE & ENVIRONMENT CO-OP

INFORMATION SESSION

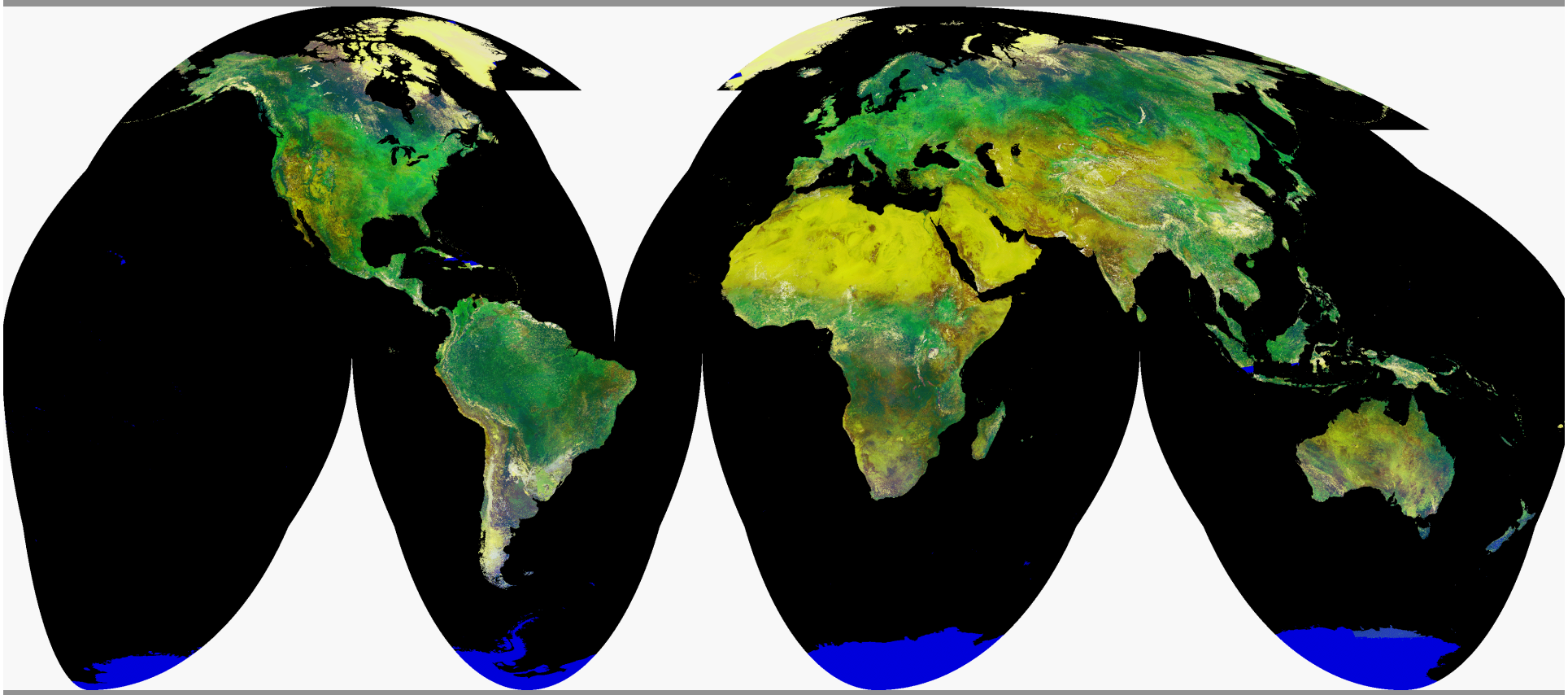
ADD WORK EXPERIENCE TO YOUR DEGREE

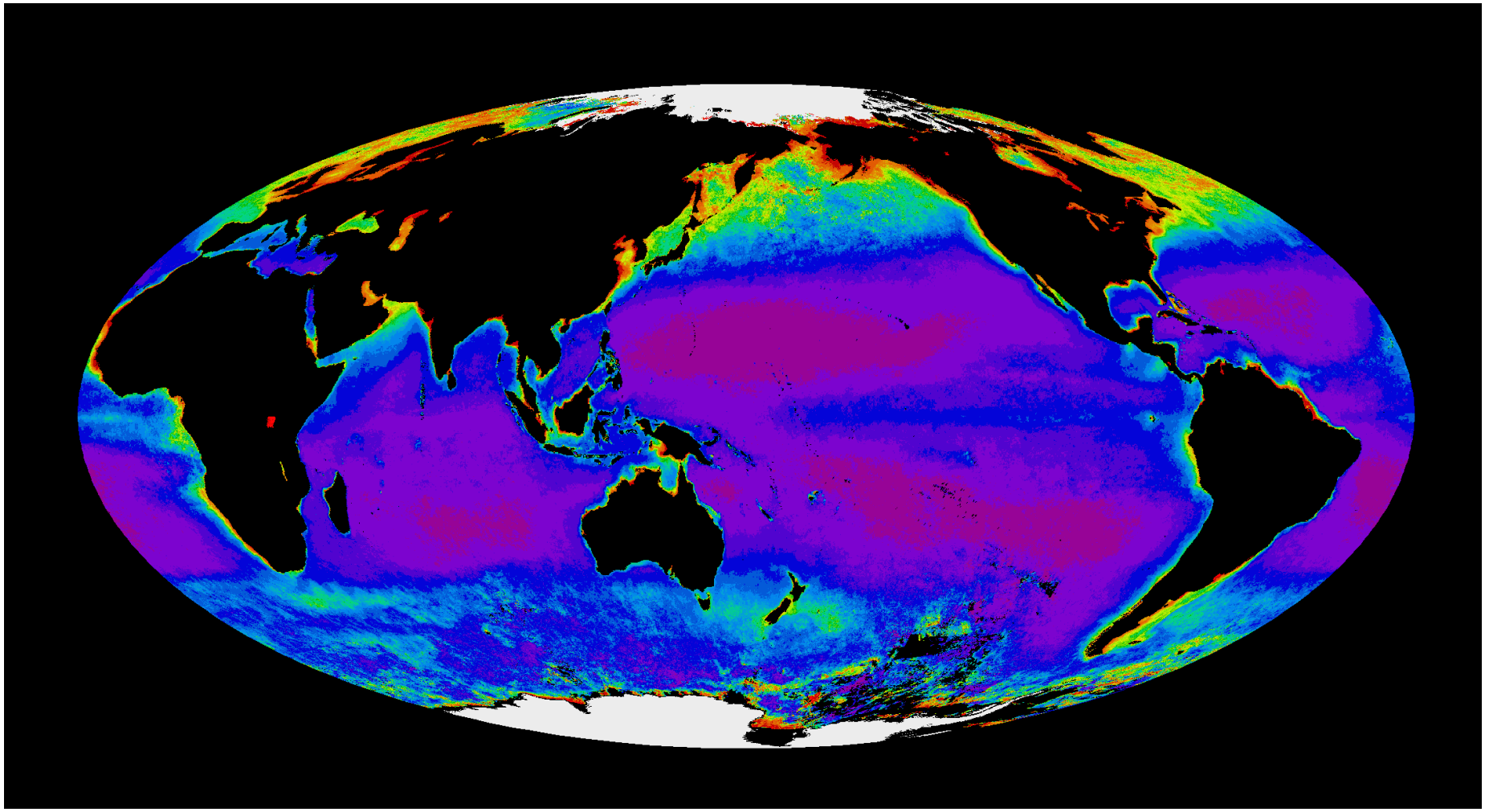
SEPTEMBER 18, 2019 (WEDNESDAY) | 12:30 PM-1:20 PM (AQ 3154)

Course Website

www.sfu.ca/biology/courses/bisc204

- All important course information will be posted to the above website
- Lecture notes (available prior to lecture), lecture slides (after), syllabus
- **This class DOES NOT use Canvas for class announcements**





Patterns of global aquatic productivity.

red/orange = high chlorophyll, *purple/blue* = low chlorophyll

What drives large-scale patterns of environmental variation?

Climate

1. Light
2. Temperature
3. Precipitation
4. Wind & Ocean circulation
*** Geology (soils)**

Climate oscillations (2 examples with relevance)
1. El niño / La niña
2. Pacific Decadal Oscillation (PDO)

How do we characterize broad ecological patterns?

Biomes-based on common vegetation patterns for a given climate (temp, precip)

Some basics and some ecological effects

- The rotation of the Earth around it's axis causes daily periodicity (day vs. night)

  Circadian rhythms, individual behavior (diurnal/nocturnal/crepuscular)

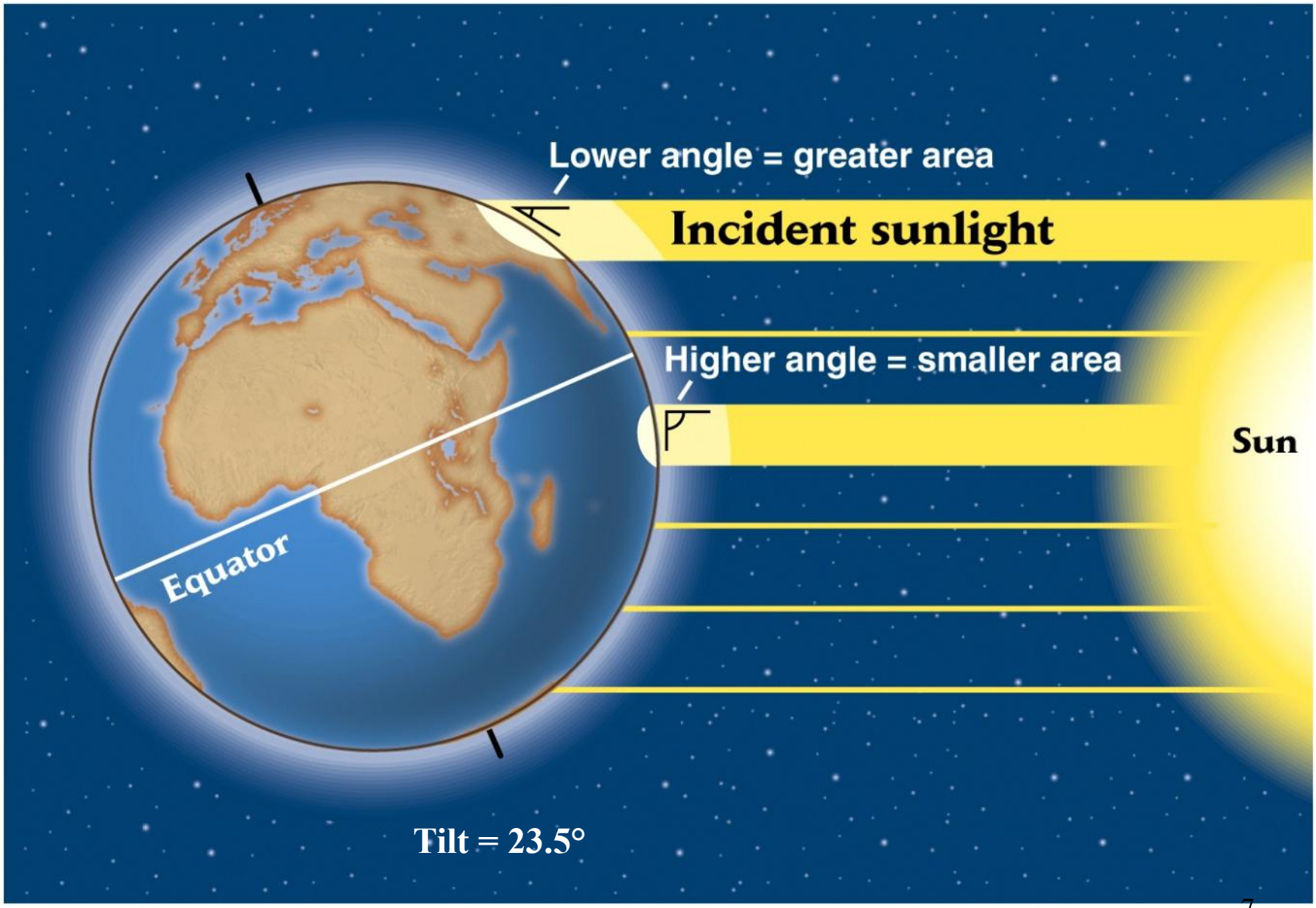
- The rotation of the moon around the Earth causes lunar cycles (tides)

  Intertidal zonation, individual behavior (movement, feeding, spawning, etc.)

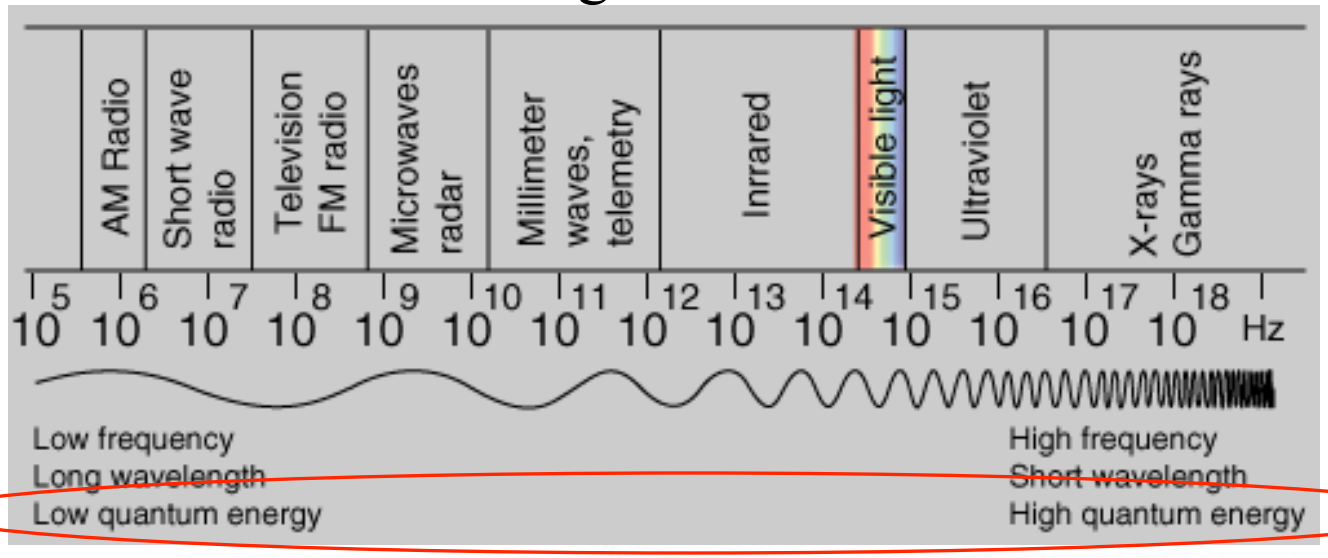
- The revolution of the Earth around the sun combined with the tilted axis (23.5°) causes seasonal patterns by hemisphere.

  Annual allocation of activity and energy (hibernation, leaf-fall, migration)

Light

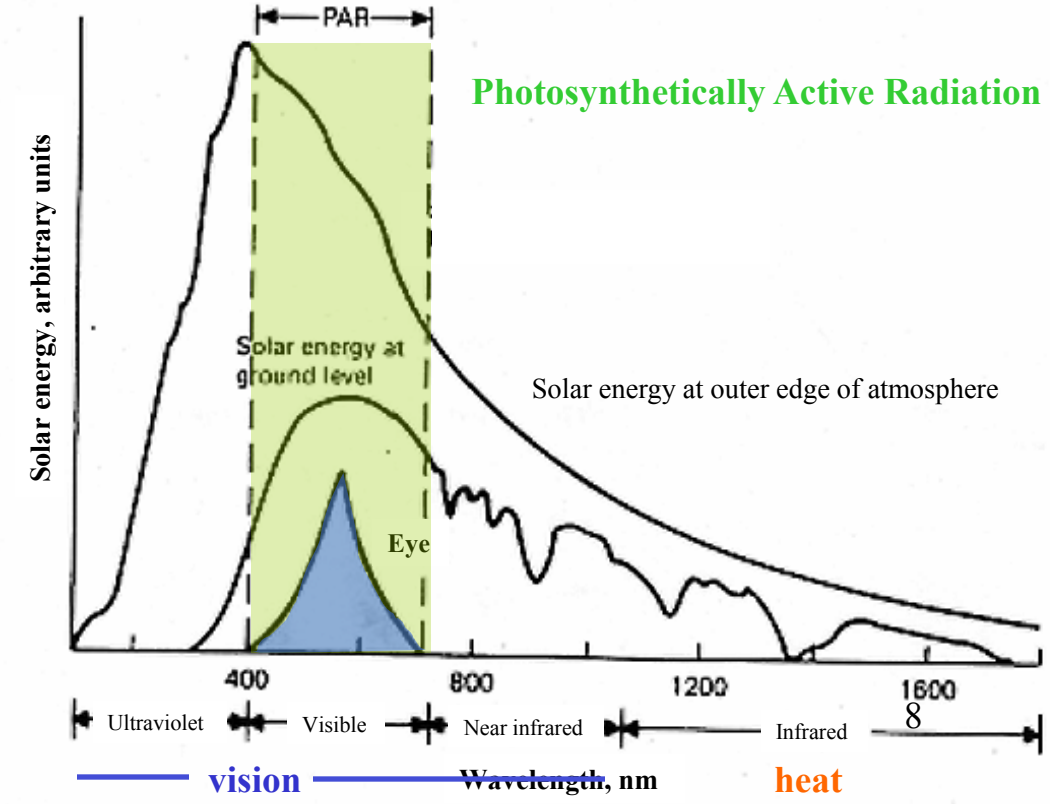

Lower angle = greater area
Incident sunlight
Higher angle = smaller area
Sun
Equator
Tilt = 23.5°

Electromagnetic Radiation



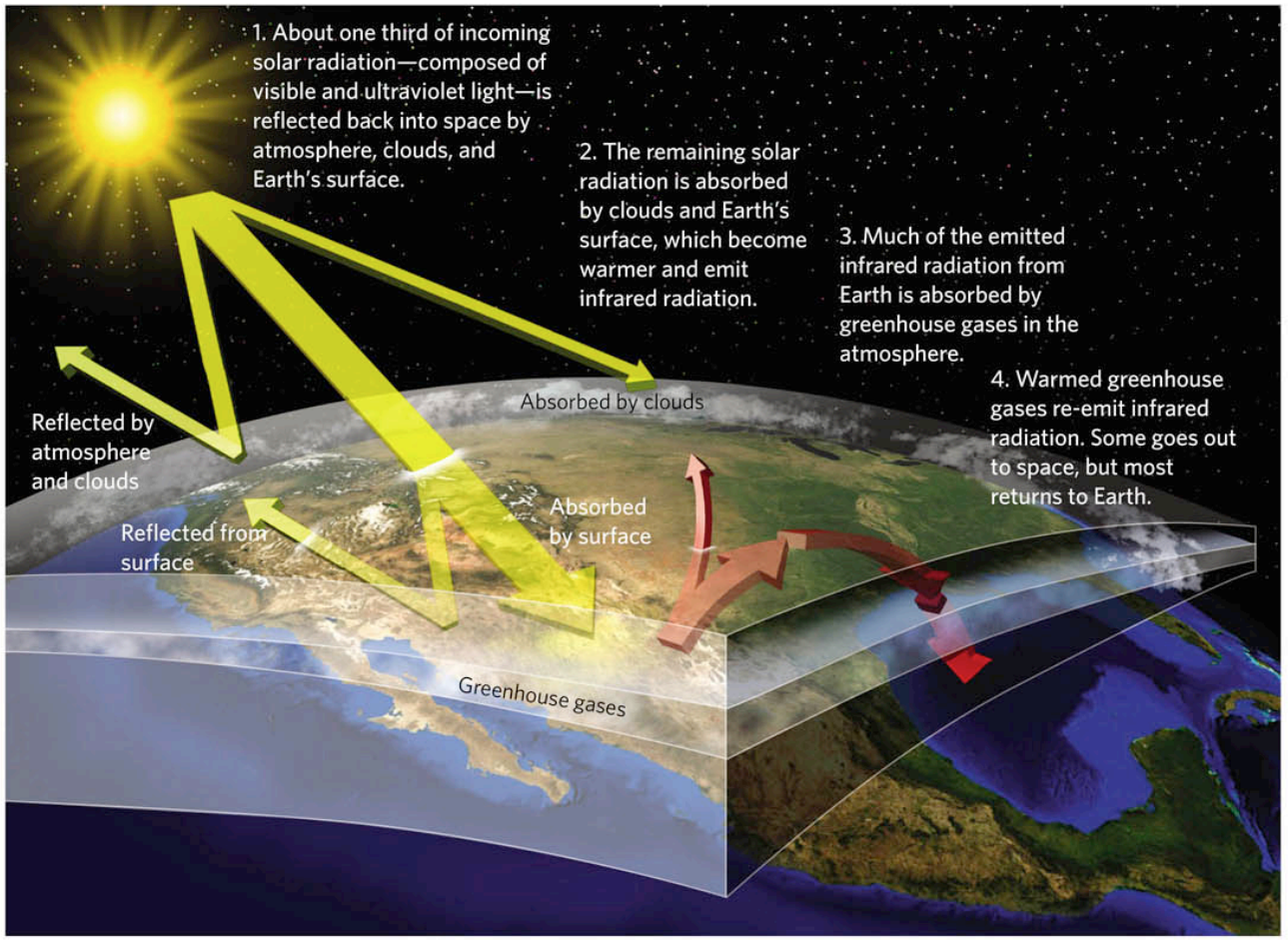
- Photons: expressed as *energy* (Joules), *wavelength* (distance between peaks, nanometers), or *frequency* (time per cycle, hertz).

- *Light* is what we call wavelengths sensed by the human eye (400-700 nm)—but really everything; radio waves, "light", and x-rays are all the same entity.

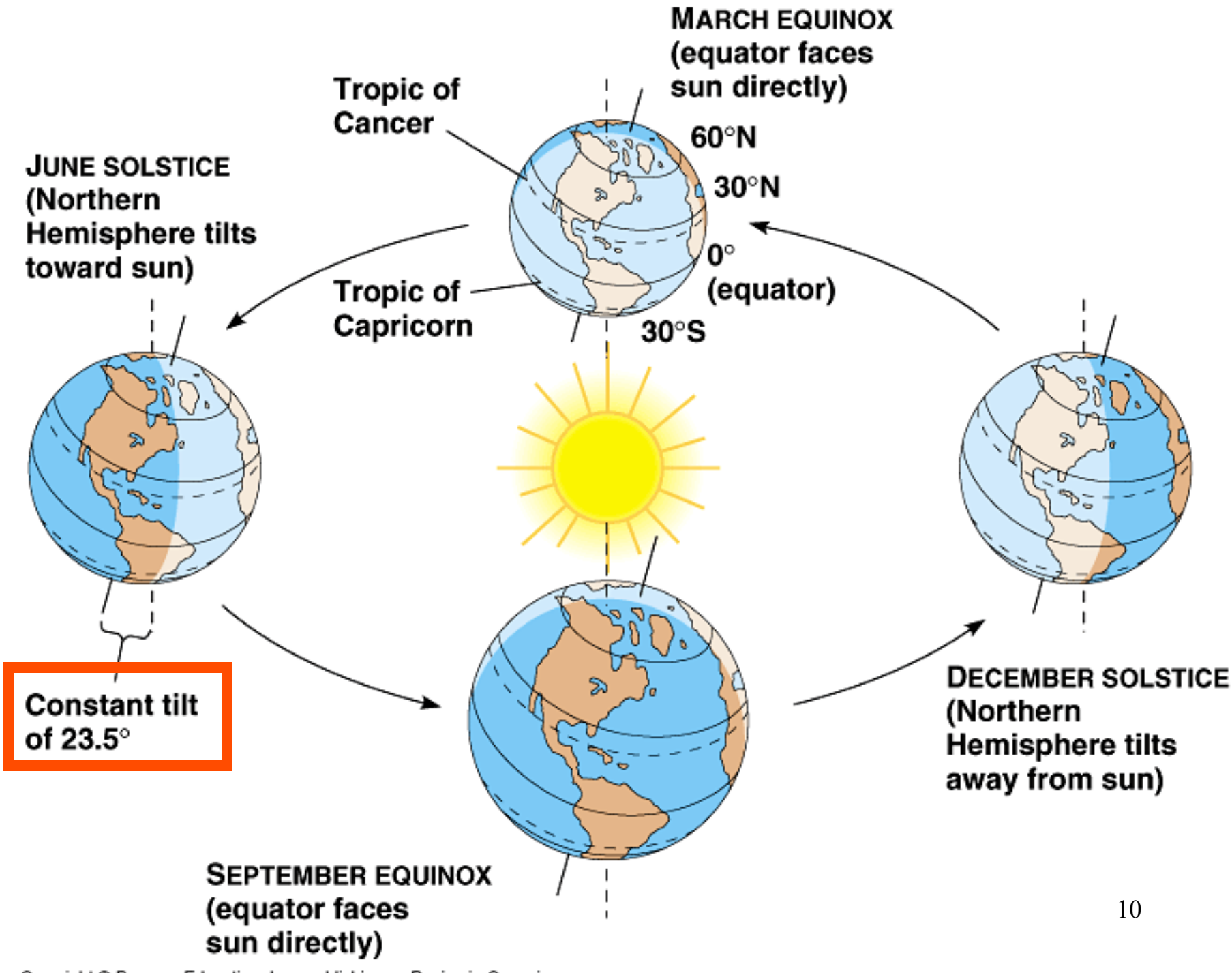


The greenhouse effect

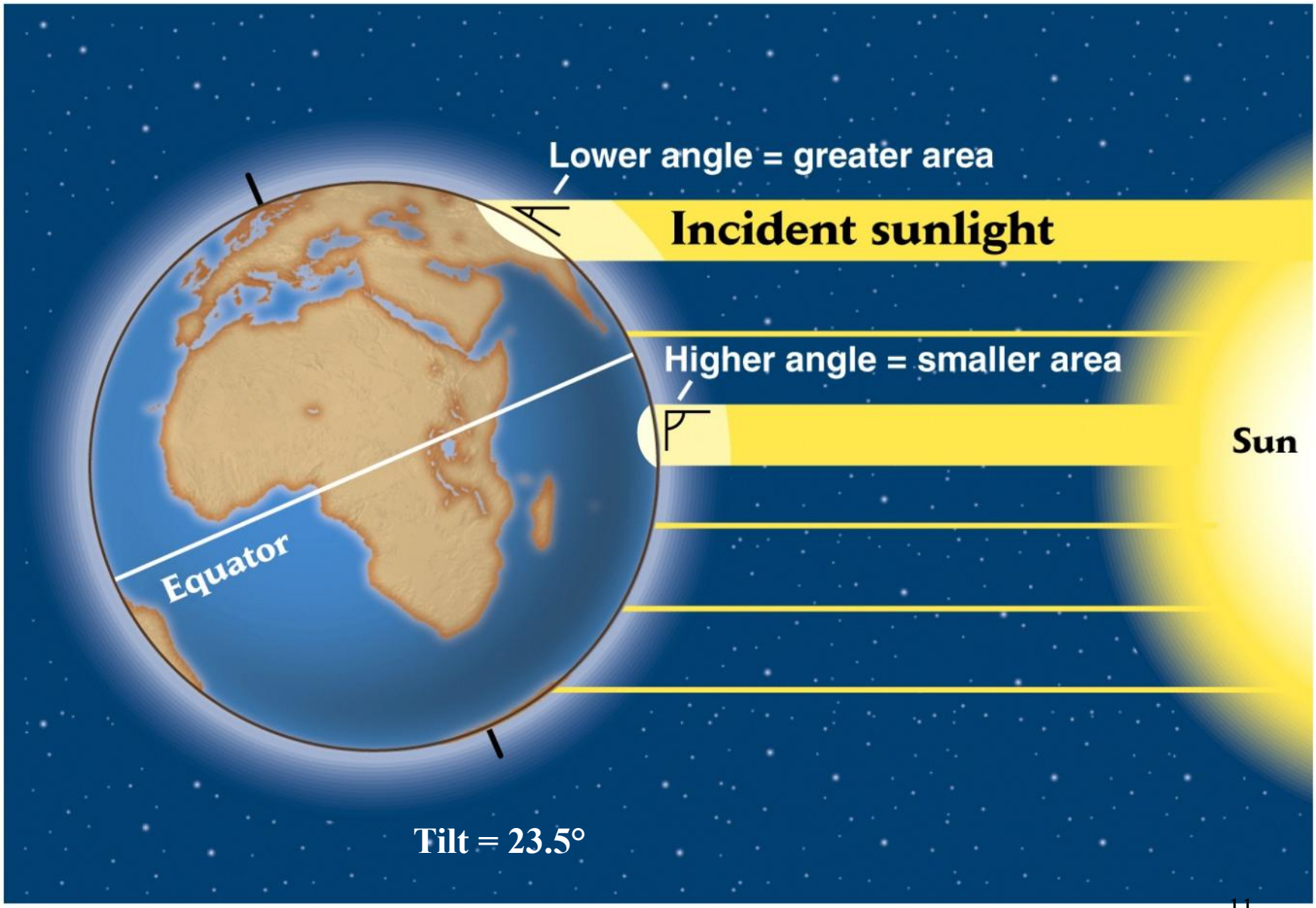
the process of solar radiation striking Earth, being converted to infrared radiation, and being absorbed and re-emitted by atmospheric gases.



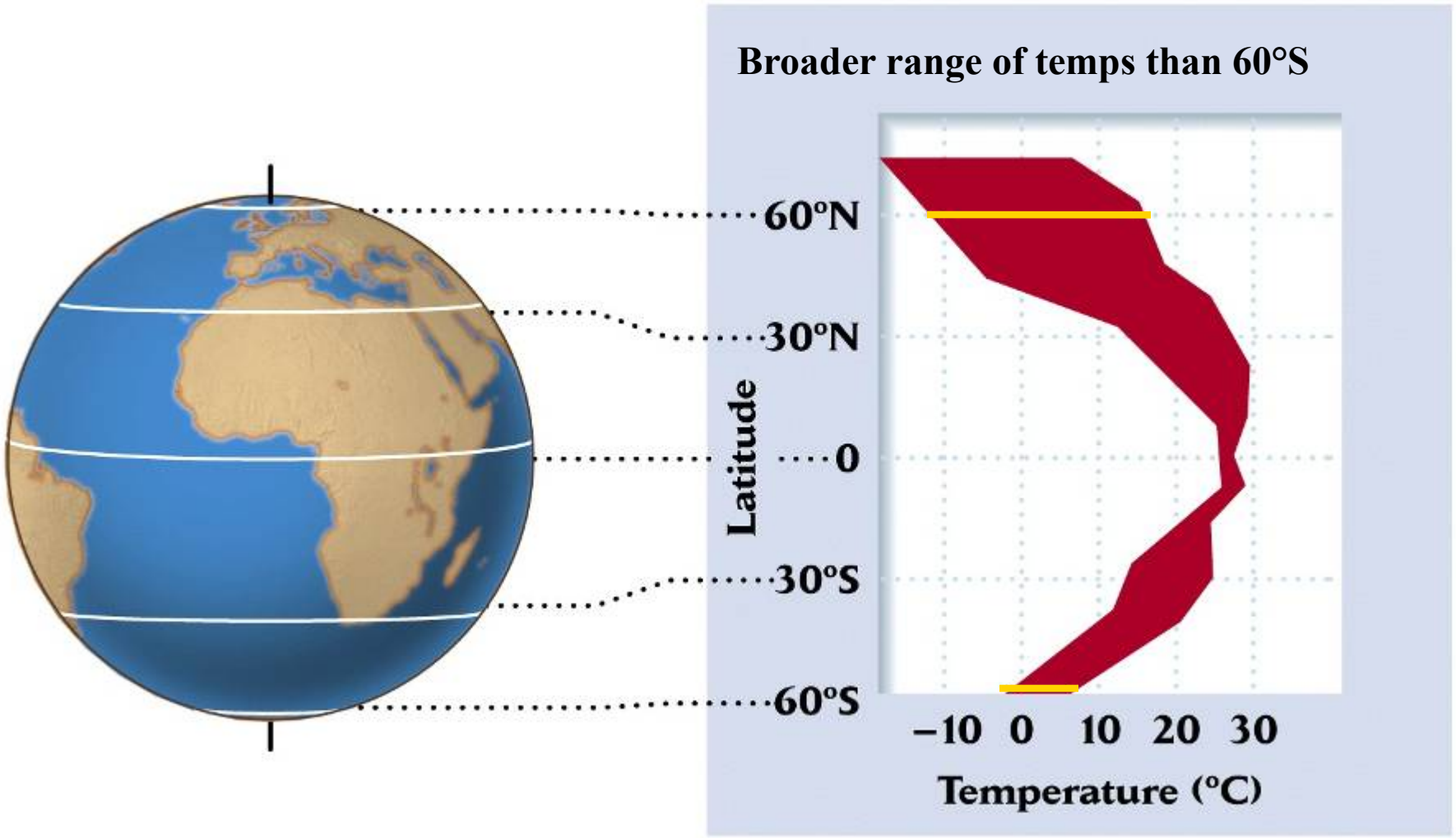
Chapter 5 Figure 05-01


MARCH EQUINOX
(equator faces
sun directly)
Tropic of
Cancer
60°N
30°N
0°
(equator)
Tropic of
Capricorn
30°S
JUNE SOLSTICE
(Northern
Hemisphere tilts
toward sun)
Constant tilt
of 23.5°
DECEMBER SOLSTICE
(Northern
Hemisphere tilts
away from sun)
SEPTEMBER EQUINOX
(equator faces
sun directly)

Temperature



What time of year is it?

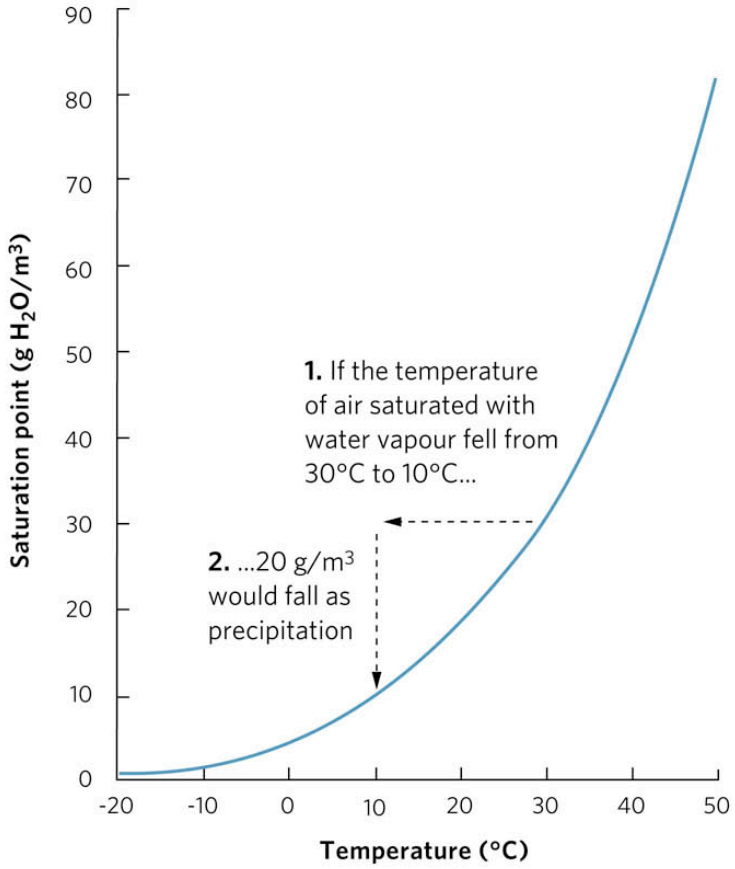


•Latitudinal pattern: solar heating decreases away from the equator (*latitude*) as sunlight is spread across larger areas

•But un-even heating due to distribution of land masses

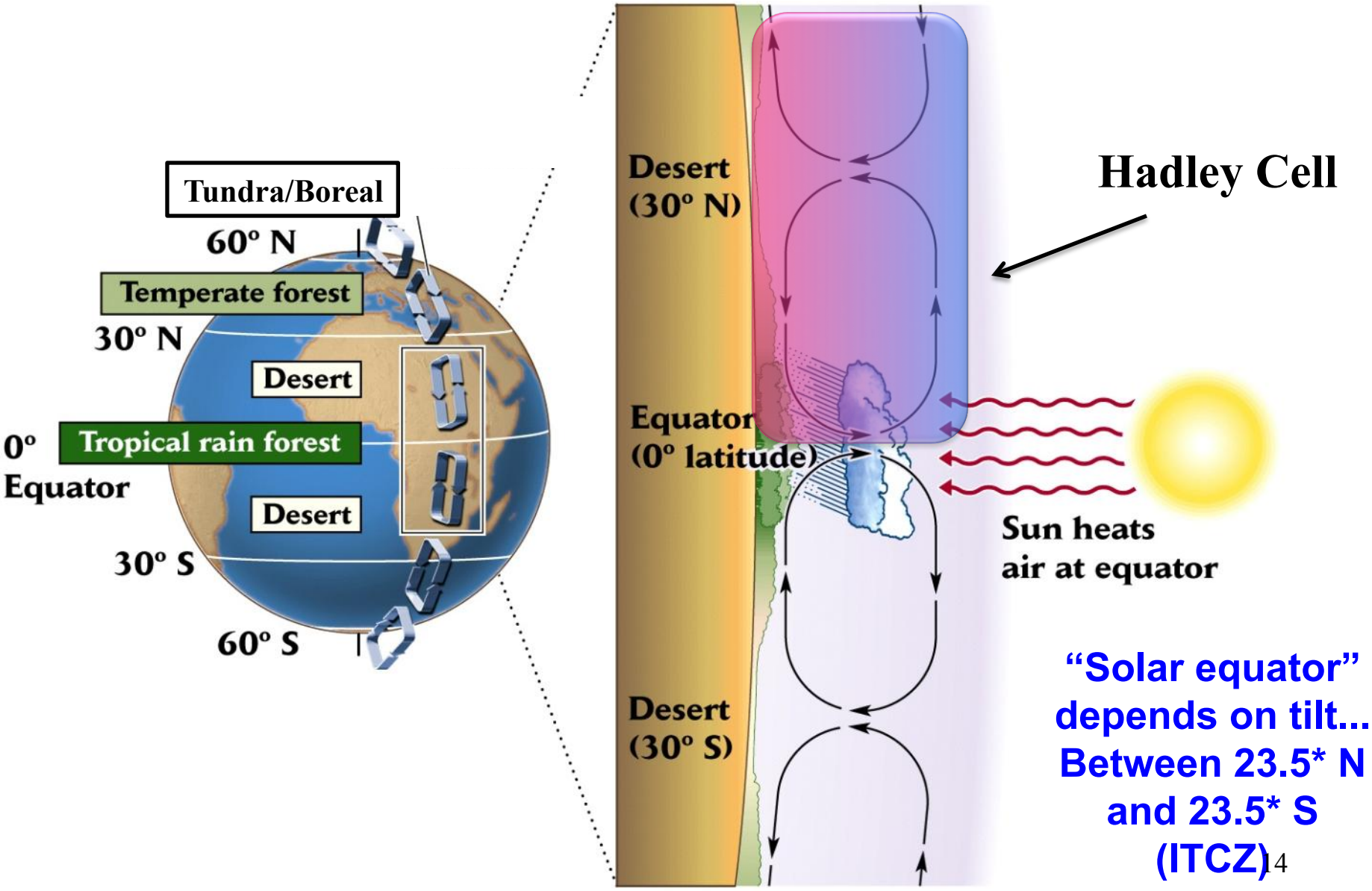
Precipitation

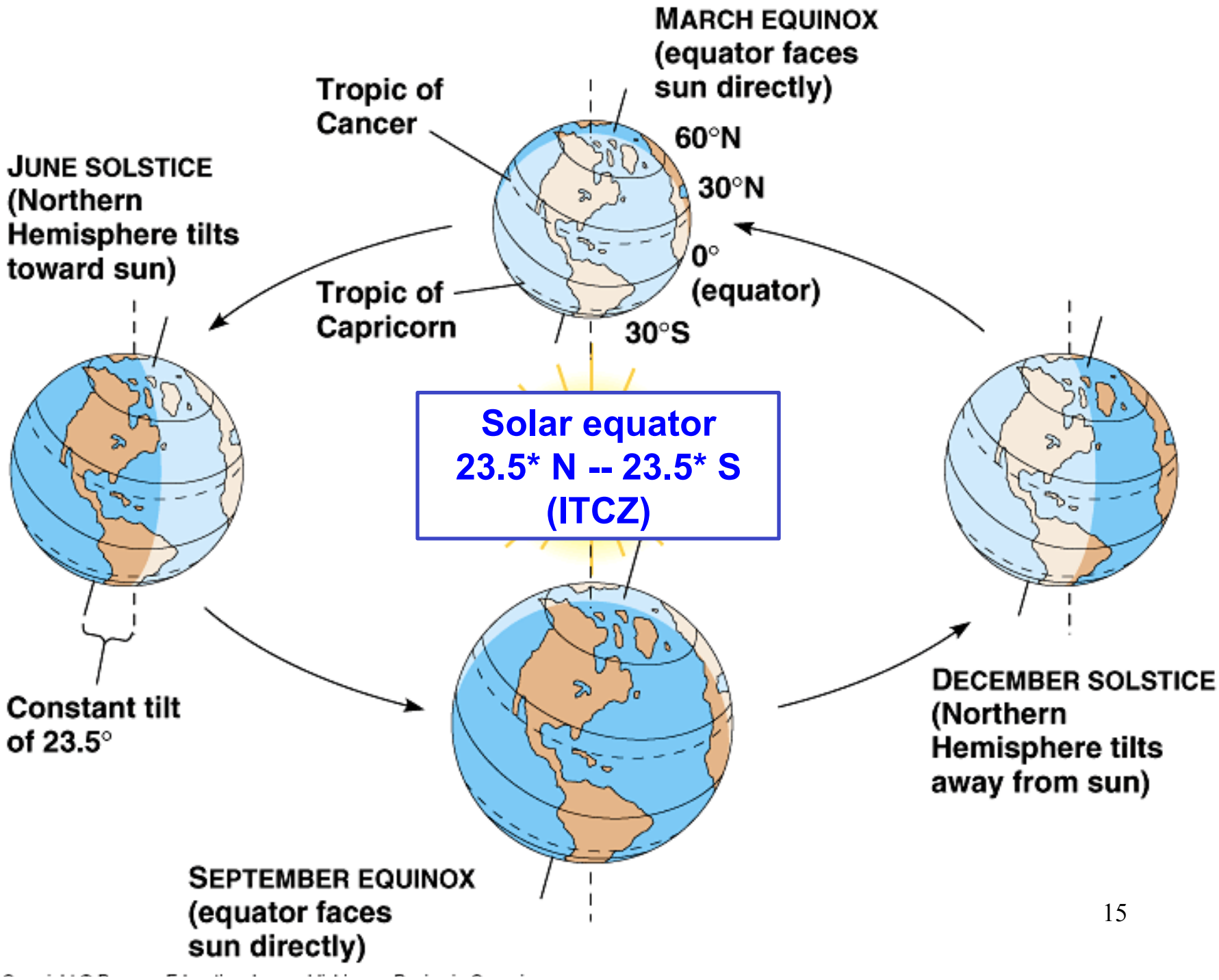
- Solar heating causes air to rise
  (lower density)
- Rising air cools, and moisture condenses (precipitation)
  why you see your breath when it's cold and not when it's hot
- As air descends, it warms and evaporates water
  - **Hadley cells** span 30 degrees latitude
- Deserts occur at latitudes of _____
- Tropical rainforests occur at latitudes of _____



Chapter 5 Figure 05-05
Ecology: The Economy of Nature, Seventh Edition

Latitudinal variation in precipitation

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(Northern
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Solar equator
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(ITCZ)
Constant tilt
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DECEMBER SOLSTICE
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SEPTEMBER EQUINOX
(equator faces
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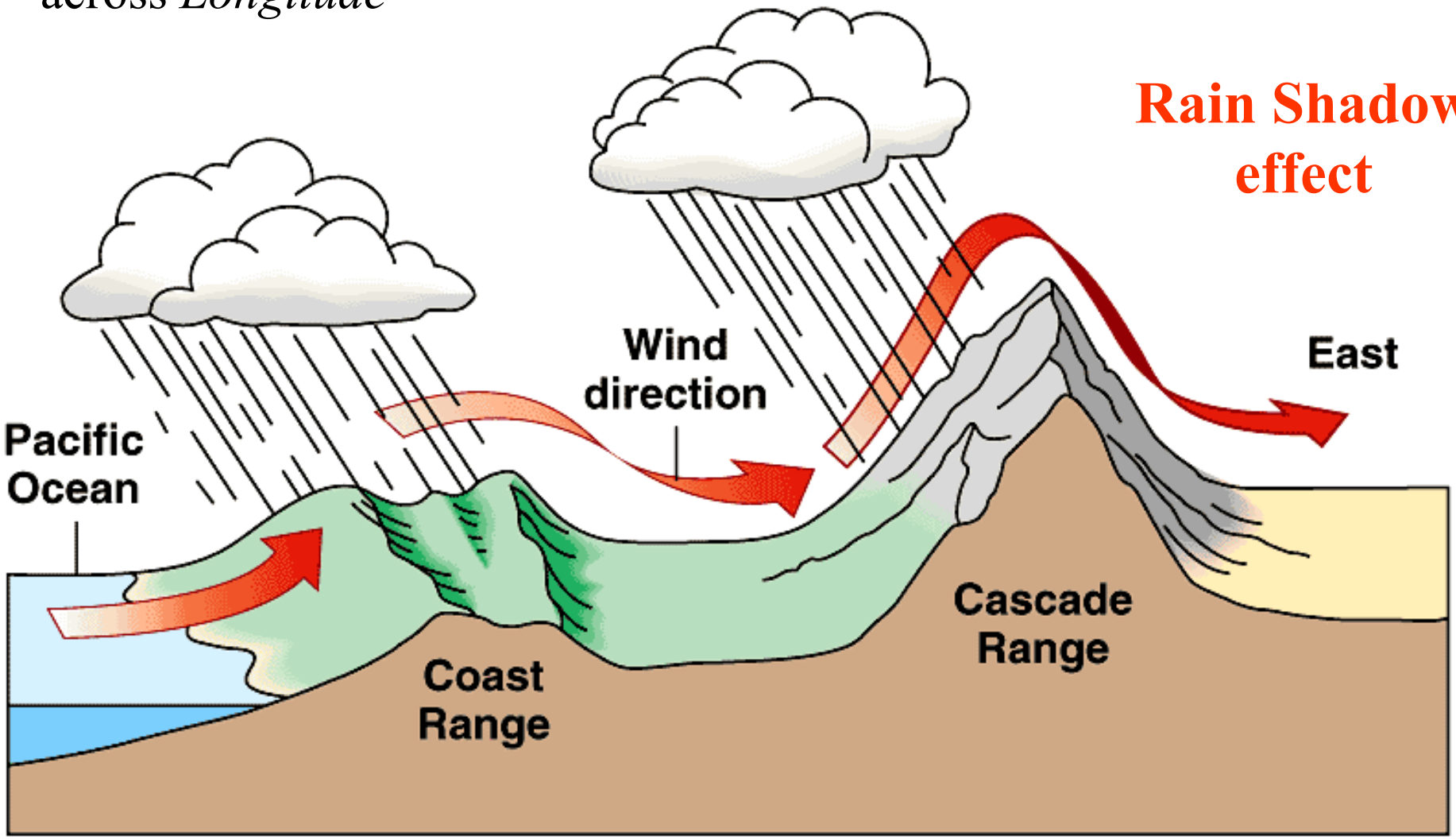
Similar patterns can occur across *Longitude*




What's grows out here?
What's grows out here?
What's going on here??

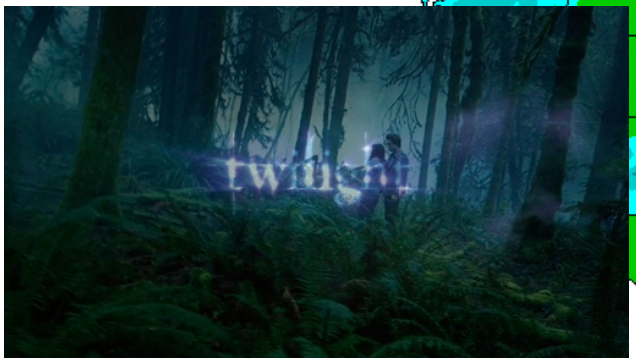
Where should you go on vacation in Washington?

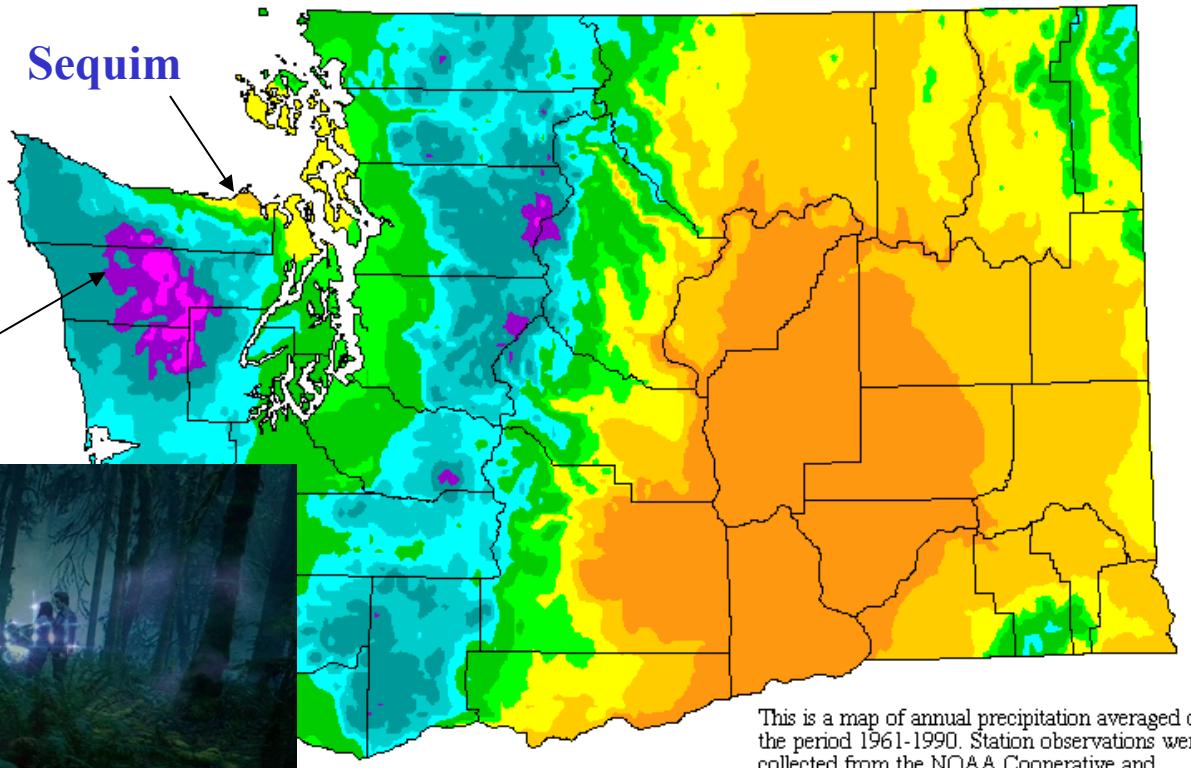
Average Annual Precipitation

Washington

Sequim

Forks





This is a map of annual precipitation averaged over the period 1961-1990. Station observations were collected from the NOAA Cooperative and USDA-NRCS SnoTel networks, plus other state and local networks. The PRISM modeling system was used to create the gridded estimates from which this map was made. The size of each grid pixel is approximately 4x4 km. Support was provided by the NRCS Water and Climate Center.

Legend (in inches)

Under 10	60 to 80
10 to 20	80 to 100
20 to 30	100 to 140
30 to 40	140 to 180
40 to 60	Above 180

For information on the PRISM modeling system, visit the SCAS web site at http://www.ocs.orst.edu/prism

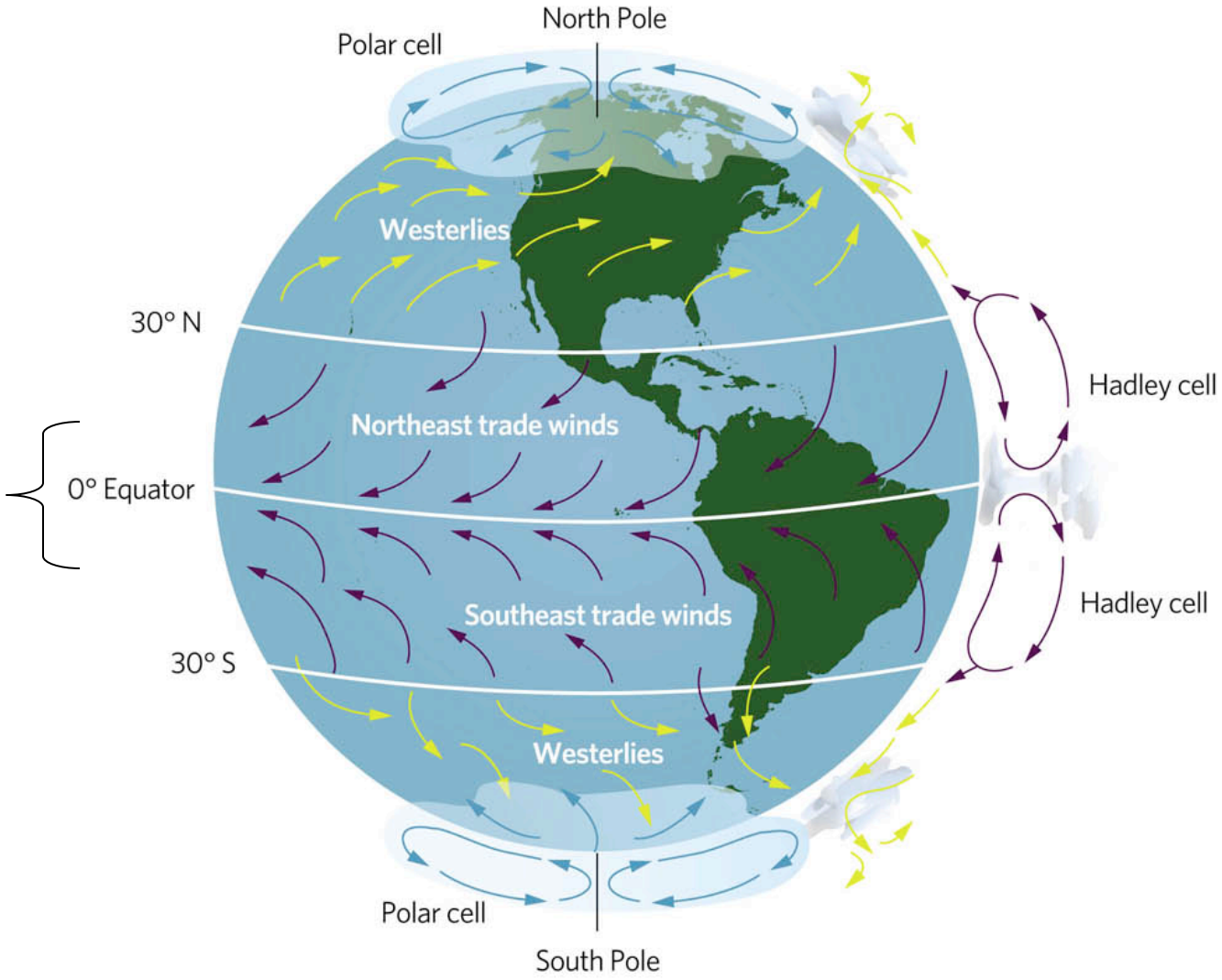
The latest PRISM digital data sets created by the SCAS can be obtained from the Climate Source at http://www.climatesource.com

Winds

- Air lags behind the rotation of the earth, lagging more where the earth spins faster (low latitudes)

- Generally:
  - » High latitudes = westerlies (*from* the west)
  - » Mid latitudes = strong trade winds (*from* the NE or SE)
  - » Equator = little to no wind (aka “doldrums”)

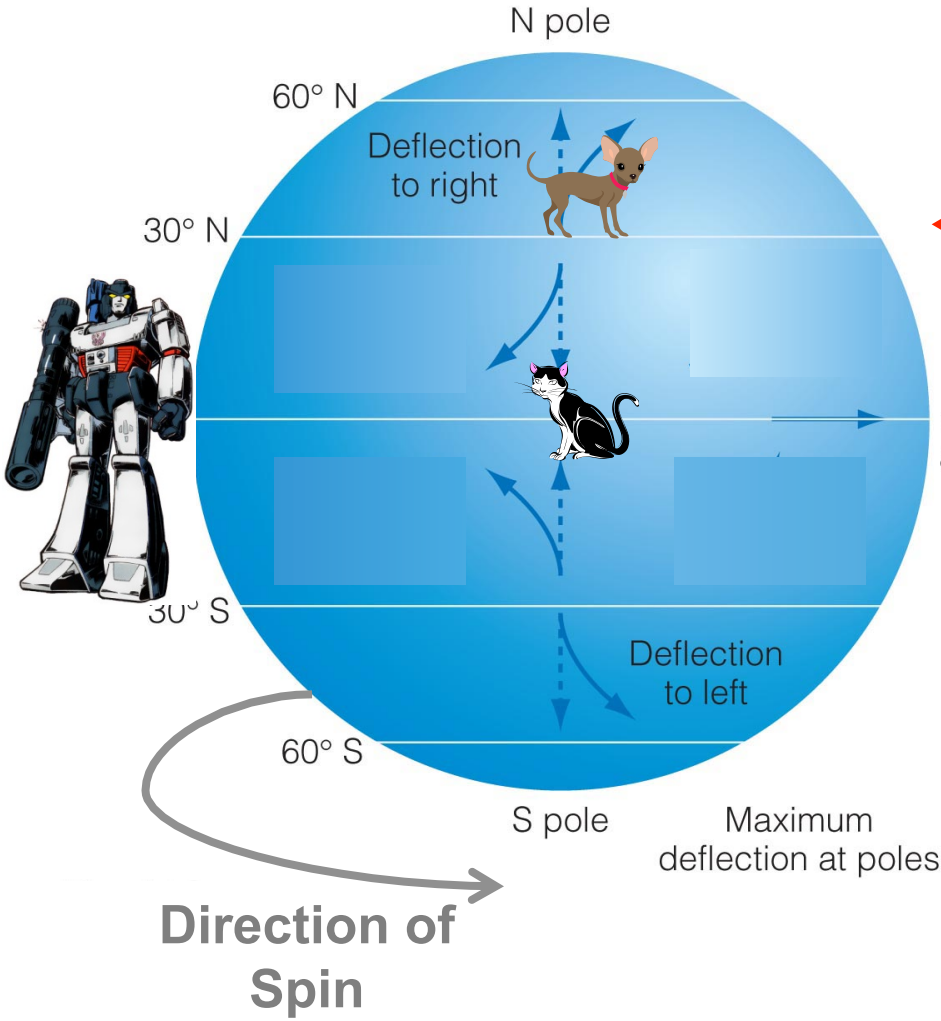
Doldrums
Inter-tropical convergence zone



Chapter 5 Figure 05-10
Ecology: The Economy of Nature, Seventh Edition

WINDS

Coriolis effect the deflection in the pattern of air flow due to differences in rotation speed



Who wins? **Tie!**

- 1 complete rotation / 24hr

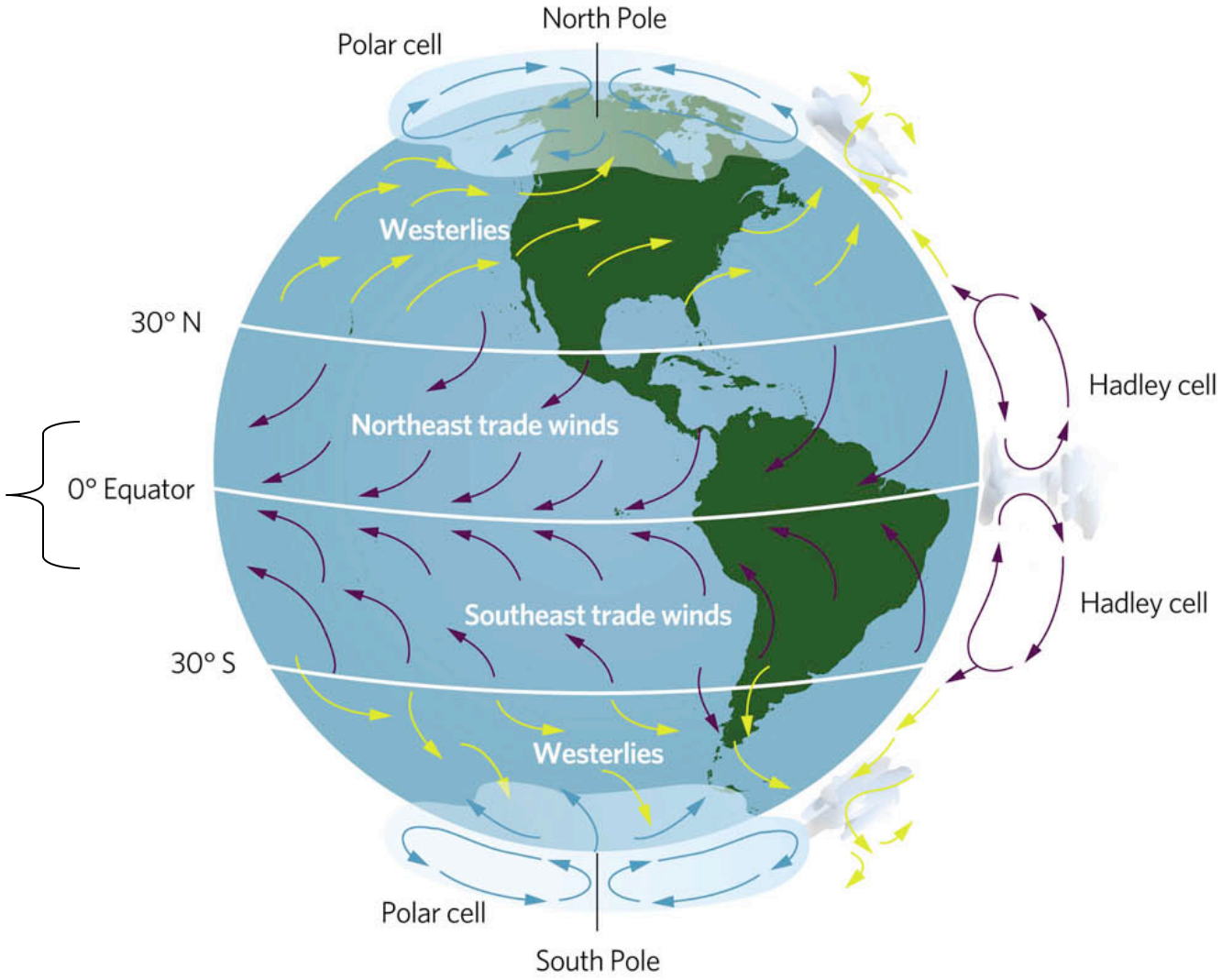
← Slower near the poles

How does rotation speed compare?

← Largest circumference has fastest rotation

- **Winds deflect IN direction of spin moving toward poles**
- **AGAINST direction of spin moving toward equator**

Doldrums
Inter-tropical convergence zone



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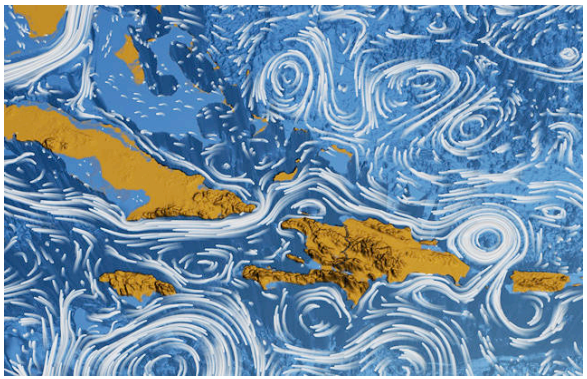
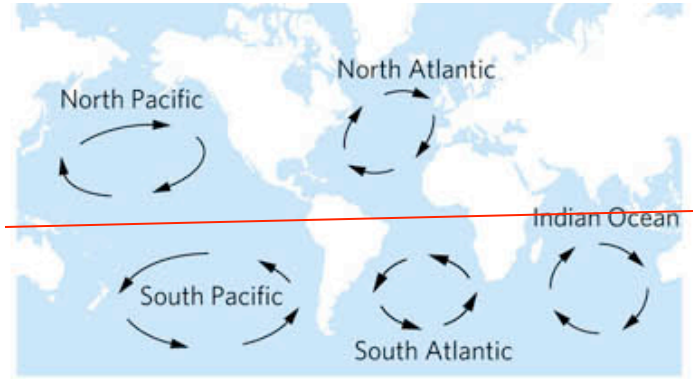


Ocean currents

- Water currents generally mimic wind patterns
- Surface water moving offshore causes ***upwelling****:* deep-water nutrients into photic (light) zone
- Ocean moderates climate (specific heat of water very high)

Gyres



Chapter 5 Figure 05-11
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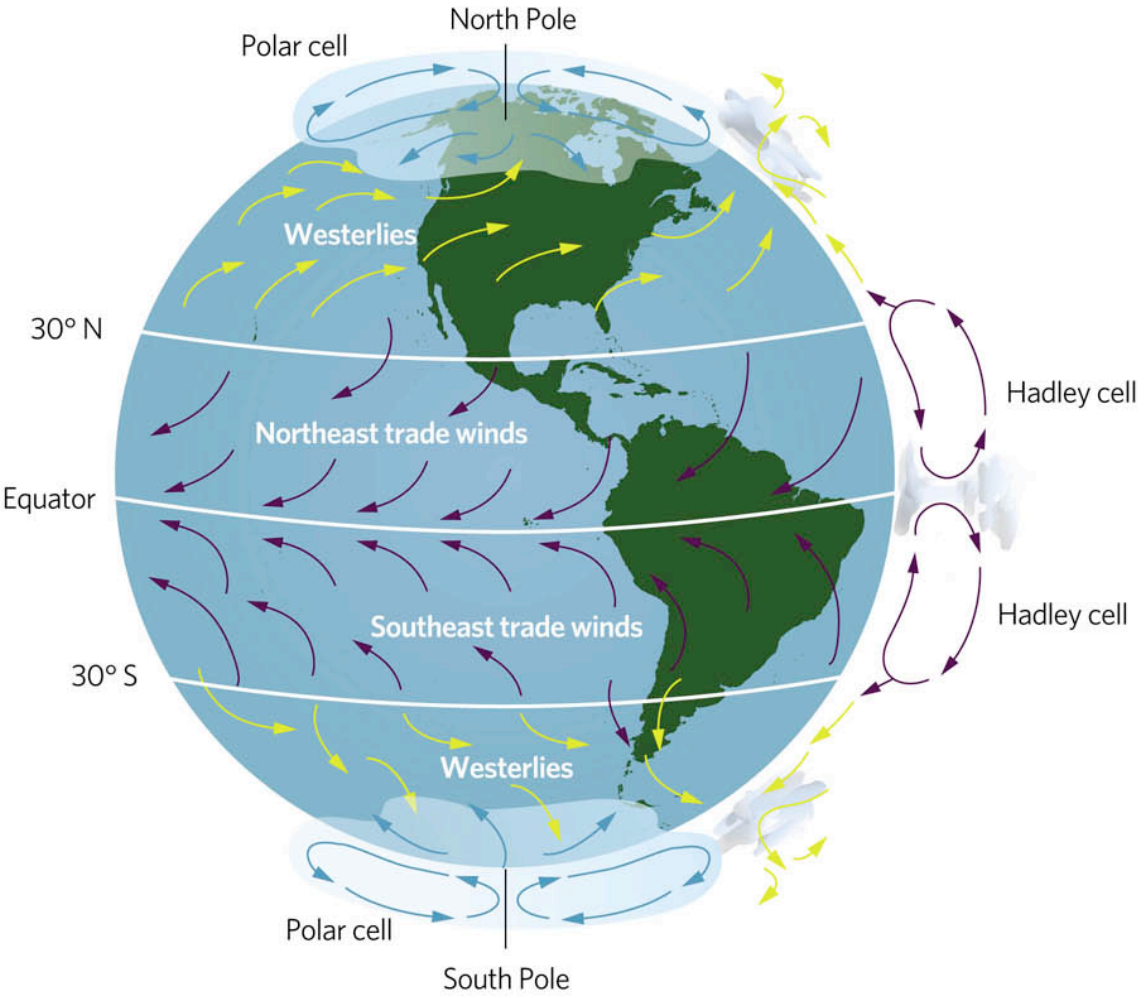

Chapter 5 Figure 05-10
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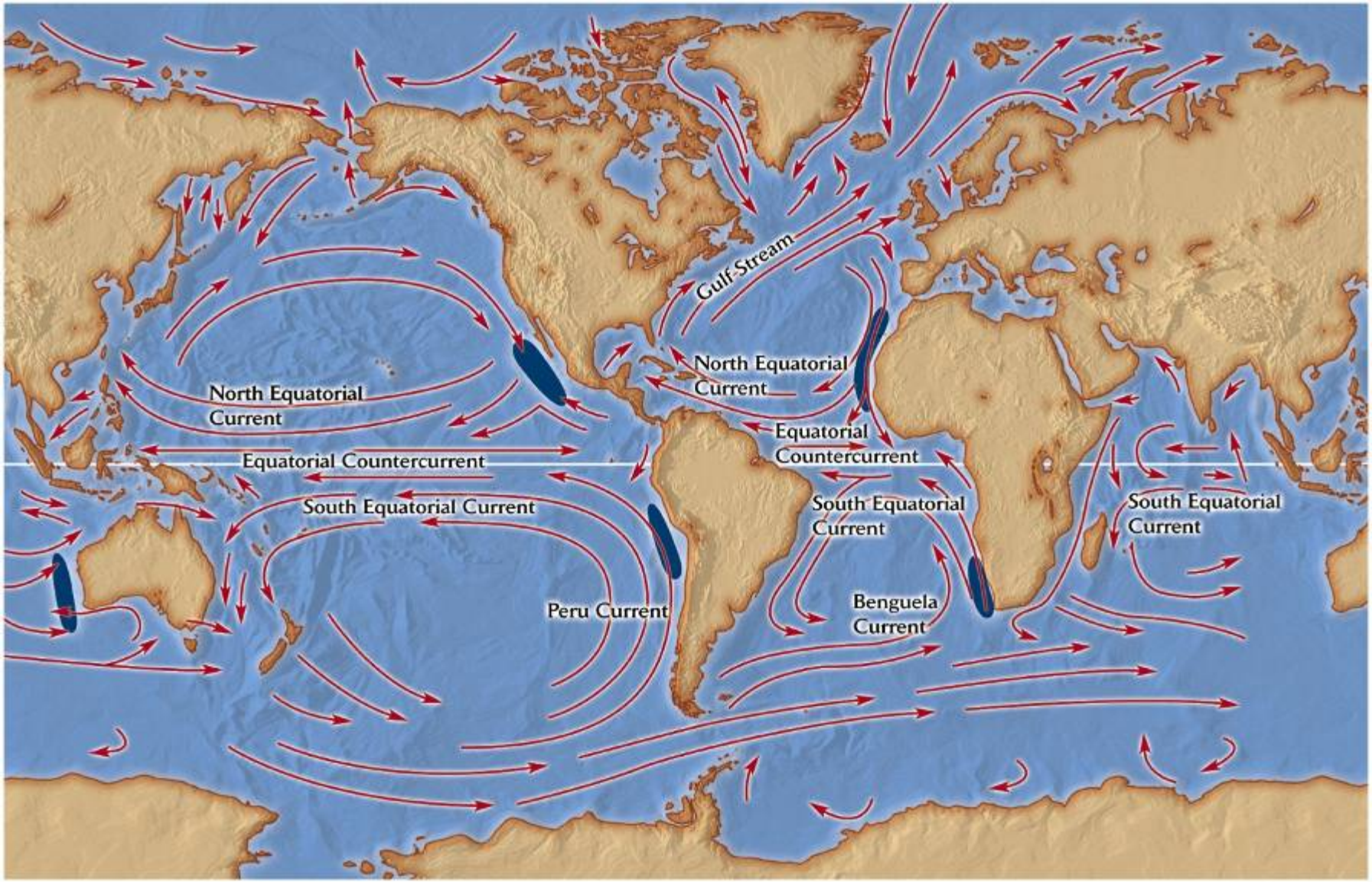
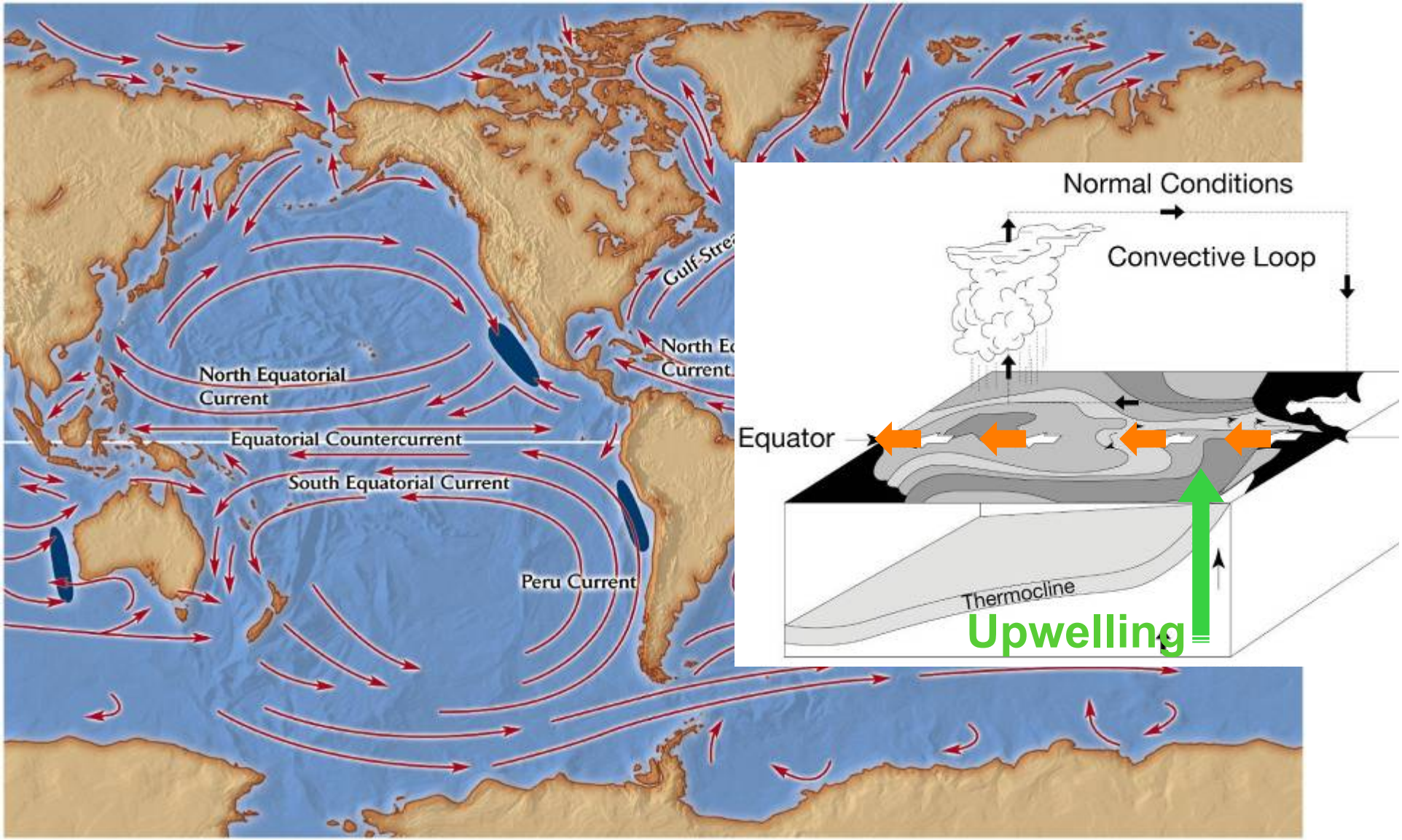


= High productivity (upwelling zones)



= High productivity (upwelling zones)

ENSO

(El niño southern osciallation)

El Niño—abnormal warming of E. tropical Pacific
La Niña—abnormal cooling of E. tropical Pacific

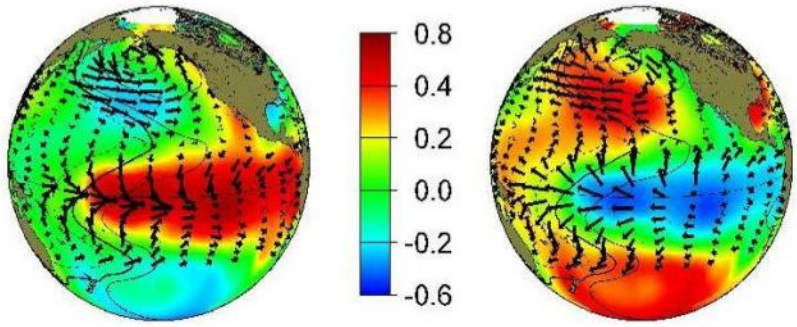
Southern Oscillation—East→West pressure difference in tropical Pacific

****GLOBAL CLIMATIC REPERCUSSIONS****

- **First noted off Peruvian Coast-**
  - Warm surface water, depressed fish catches, seabird declines, high rainfall in coastal desert
- **2-7 yrs between events**
  - increasing frequency with global warming!
- **Measured how?**
  - Deviations from long-term average
  - "Southern Oscillation Index" (SOI) = composite of sea surface temps, atmospheric pressure, prevailing wind
- **Examples:**
  - Galapagos Finches (classic Darwinian selection)

Large-scale climate cycles

El Niño-Southern Oscillation (ENSO)

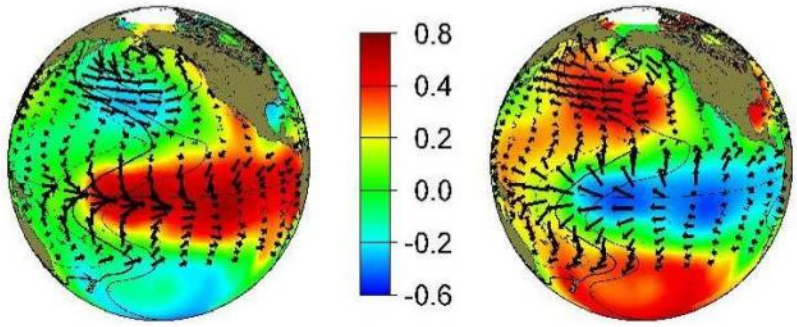


El Niño La Nina

http://tao.atmos.washington.edu/

Large-scale climate cycles

El Niño-Southern Oscillation (ENSO)



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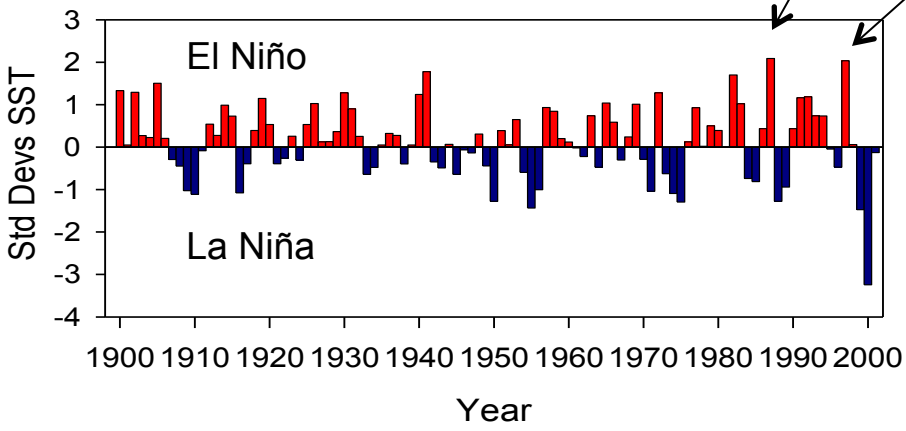
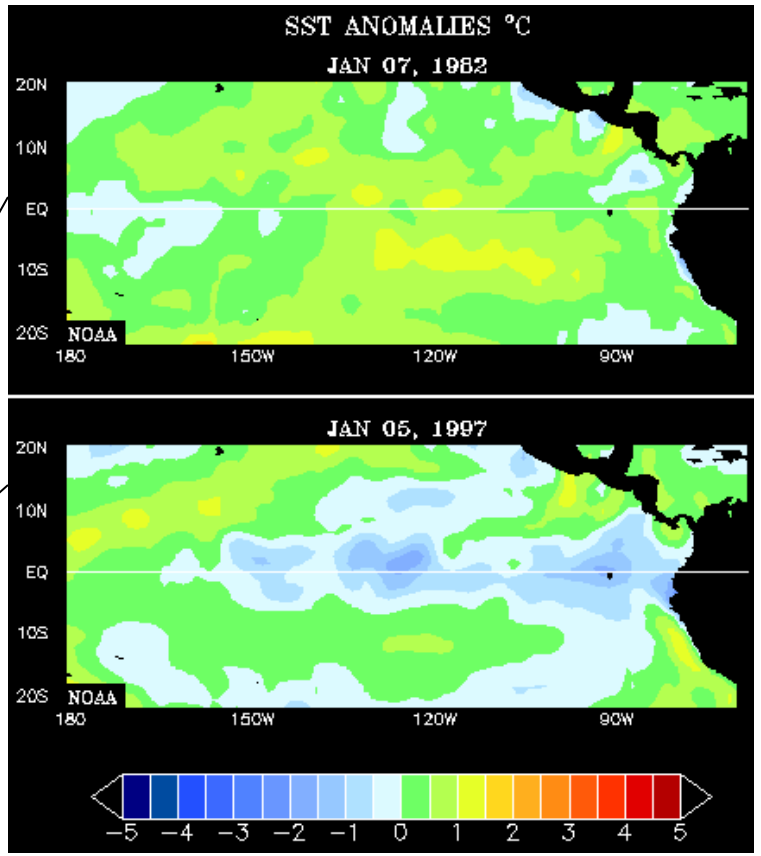


El niño



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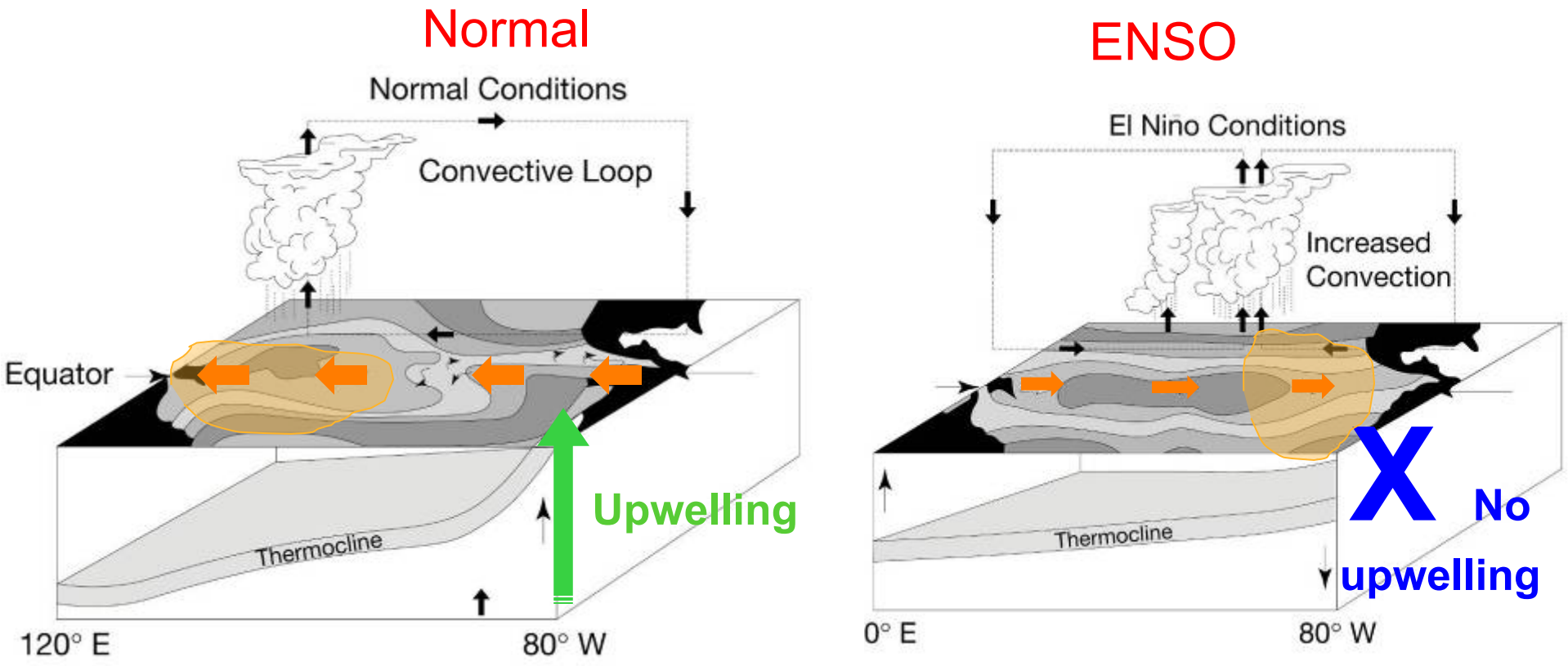
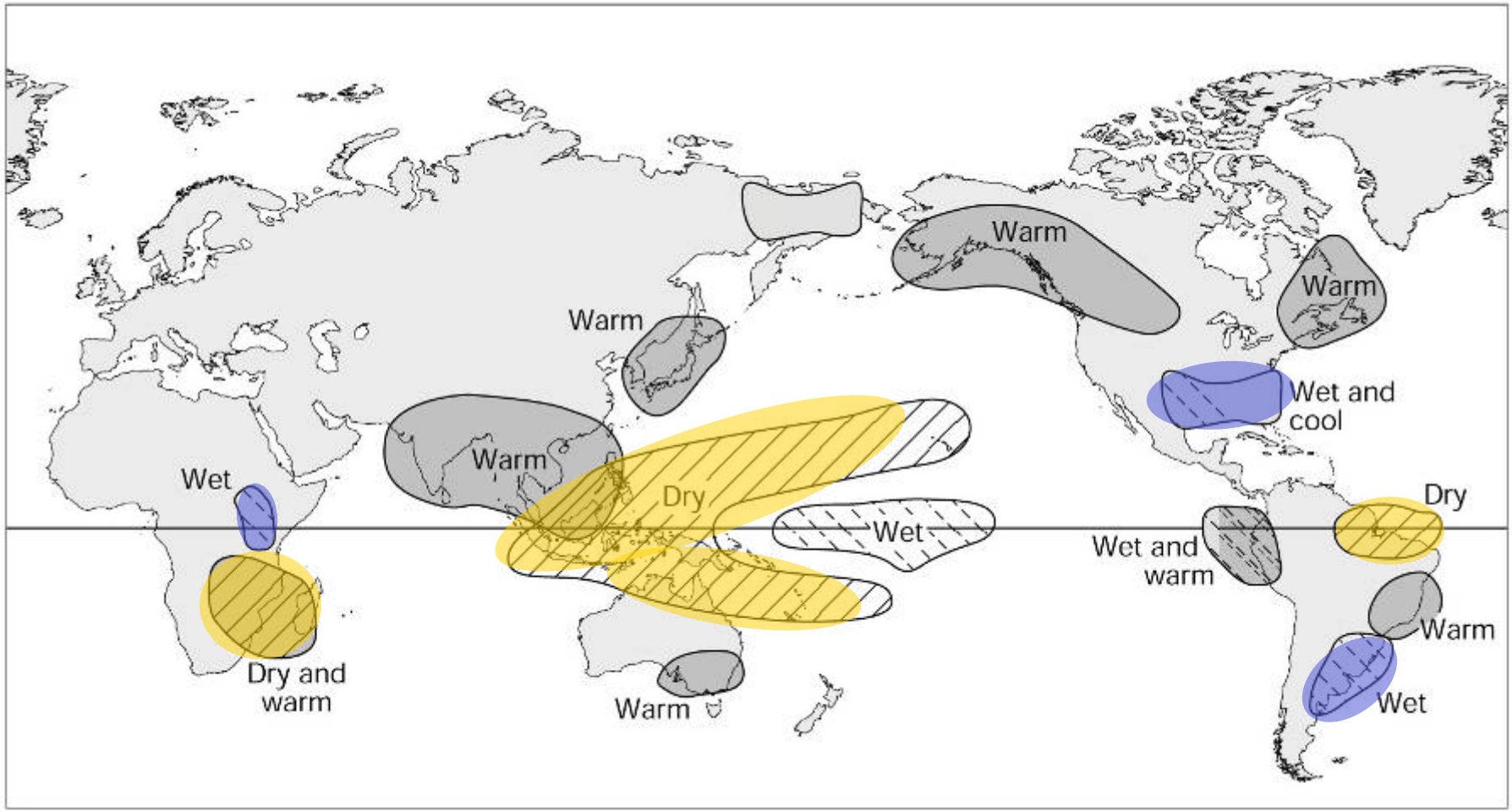
Ocean circulation and **upwelling** effects



Climate Effects of El Niño



Mt. Baker Ski Resort

Strong La niña

1998/1999
World Record
snowfall

Record low snowfall
in BC

Strong El niño

Olympic Games 2010

Galapagos Islands vegetation

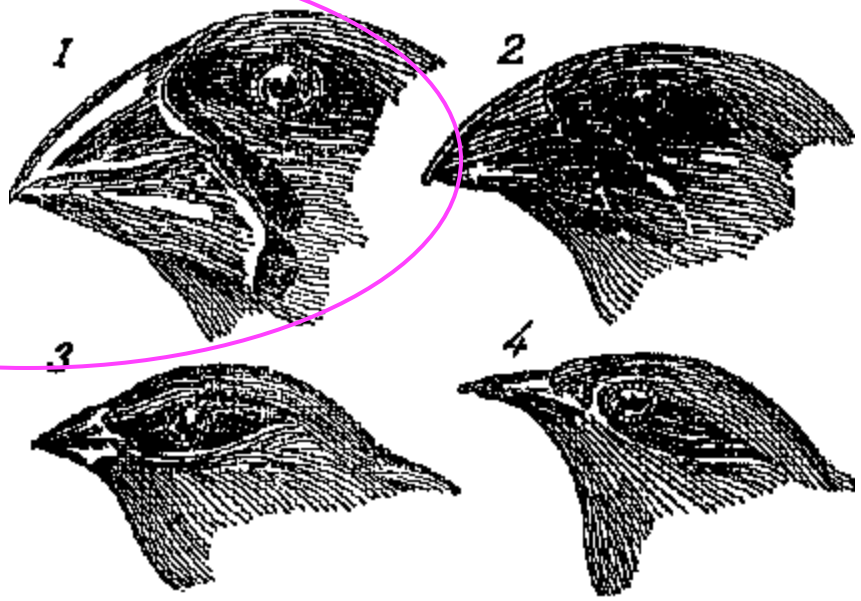
(a)

La niña winter 1982

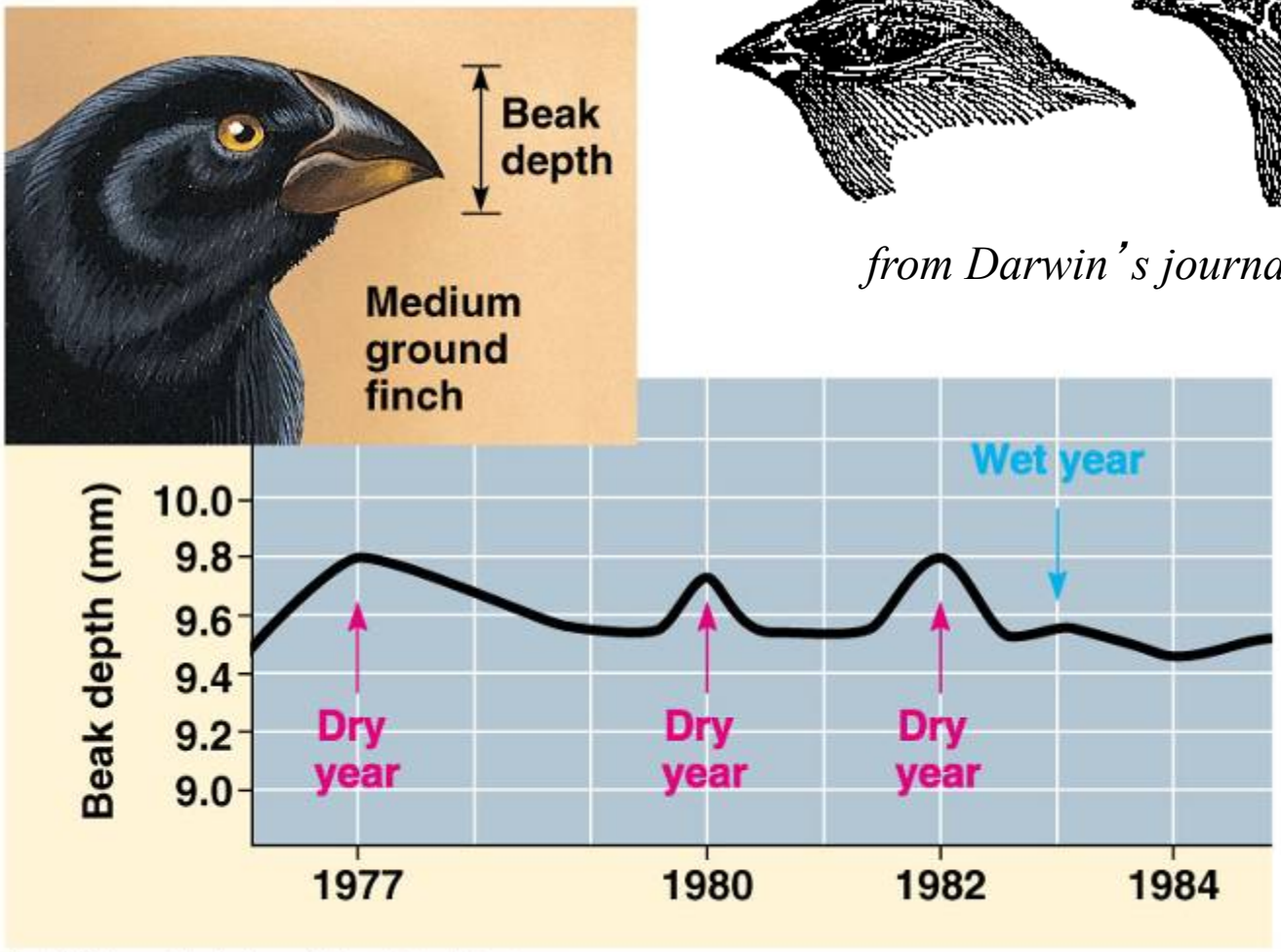
(b)

El niño winter 1983

Favored in dry years
(la niña)



from Darwin's journal 1835



Selection pressure for large beaks released in El niño & "normal" years

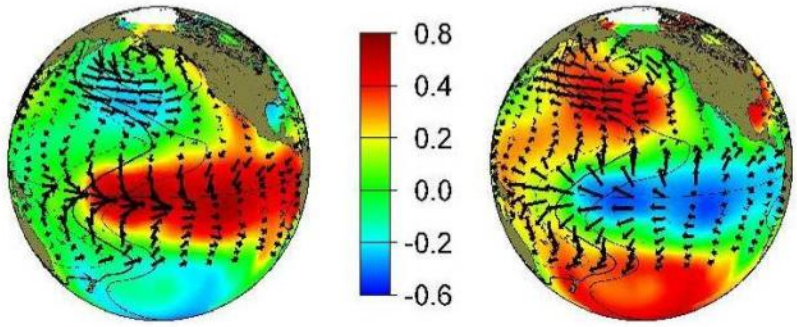
PDO

- **Pacific Decadal Oscillation**—slower but cyclic changes in dominant climate features of the North Pacific
  - Sea Surface Temps (SST), pressure, circulation, winds
  - Affects ocean temperatures and productivity
- "Warm" and "Cool" periods
- 20-30 years between "regime shifts"
- Examples:
  - Alaska and Pacific NW salmon returns (Mantua et al. 1997)

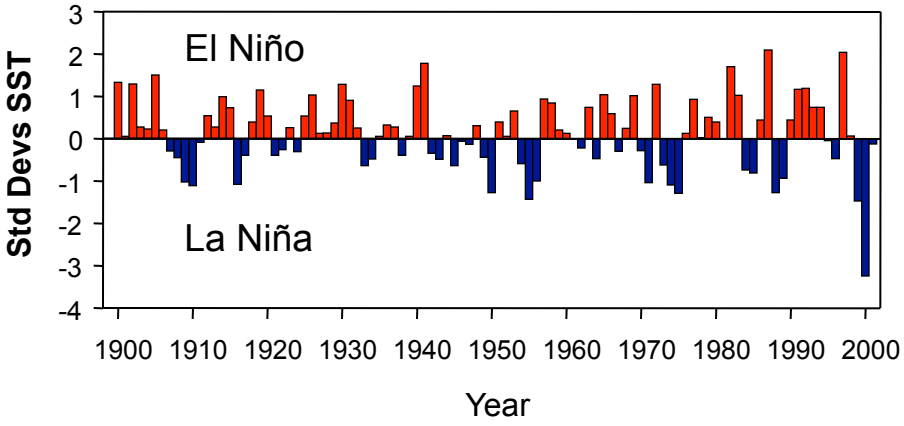
Large-scale climate cycles

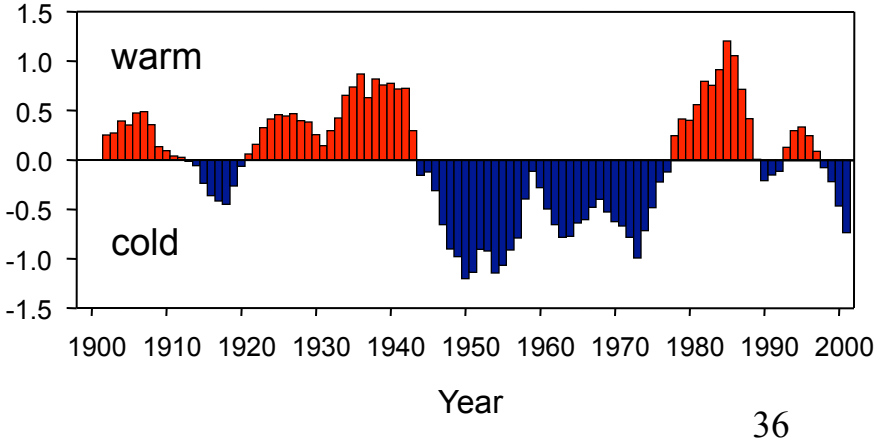
El Niño-Southern Oscillation (ENSO)

Pacific Decadal Oscillation (PDO)



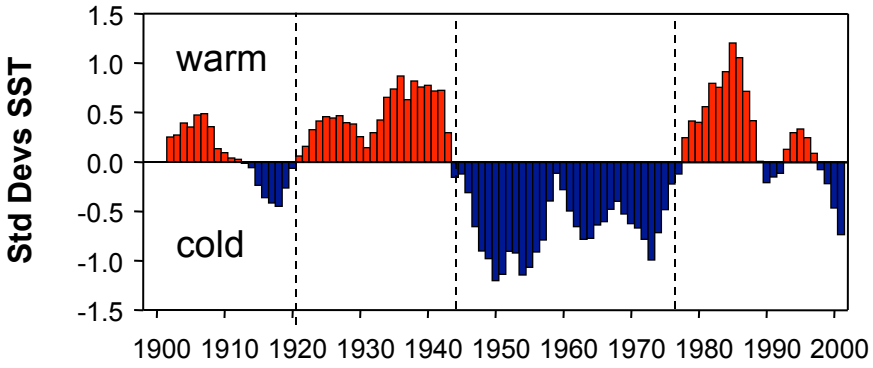
El Niño La Nina

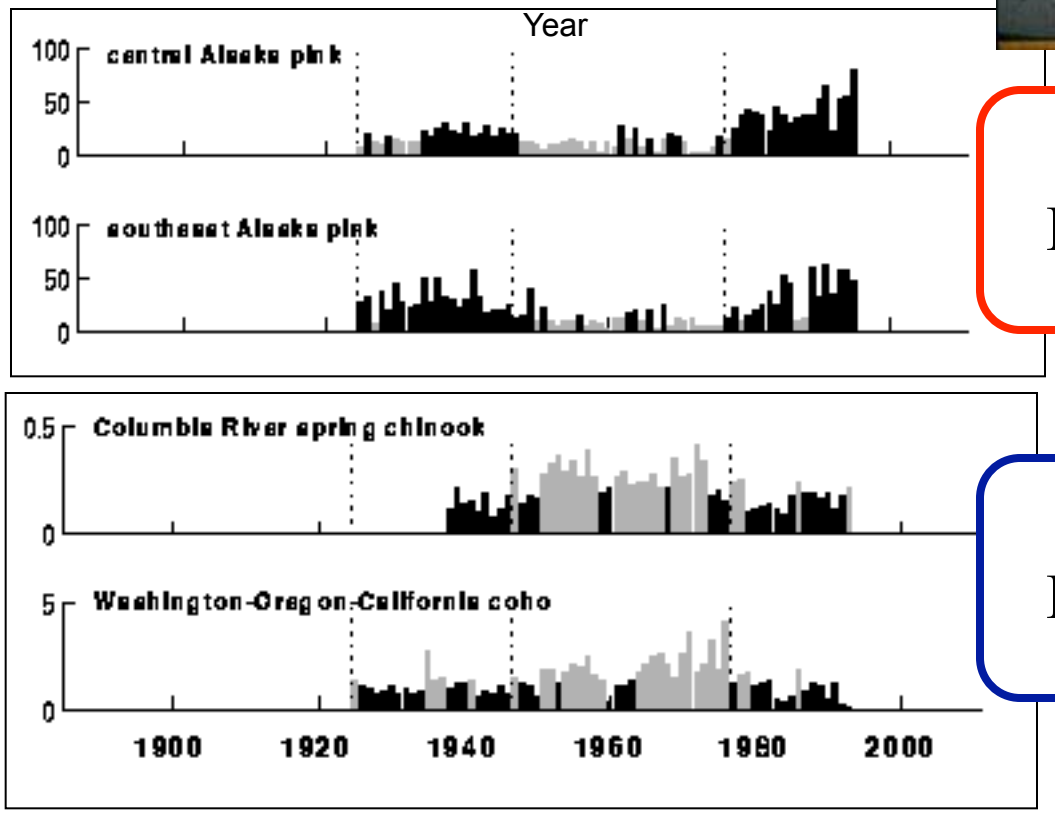


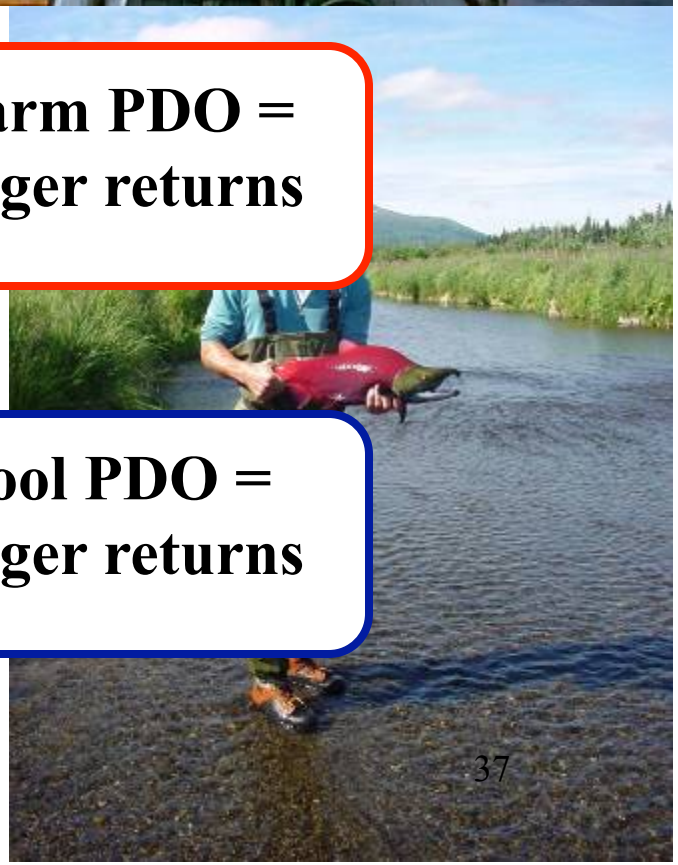


http://tao.atmos.washington.edu/

PDO and salmon catches







Warm PDO = Bigger returns

Cool PDO = Bigger returns

Mantua, N.J. et al. 1997. Bulletin American Meteorological Society 78:1069-1079

What drives large-scale patterns of environmental variation?

Climate

1. Light
2. Temperature
3. Precipitation
4. Wind & Ocean circulation

* Geology (soils)

Climate oscillations (2 examples with relevance to PNW)

1. El nino
2. Pacific Decadal Oscillation (PDO)

How do we characterize broad ecological patterns?

Biomes

Physical characteristics of the environment affect organisms—

→ drive adaptations in physiology, behavior, etc.

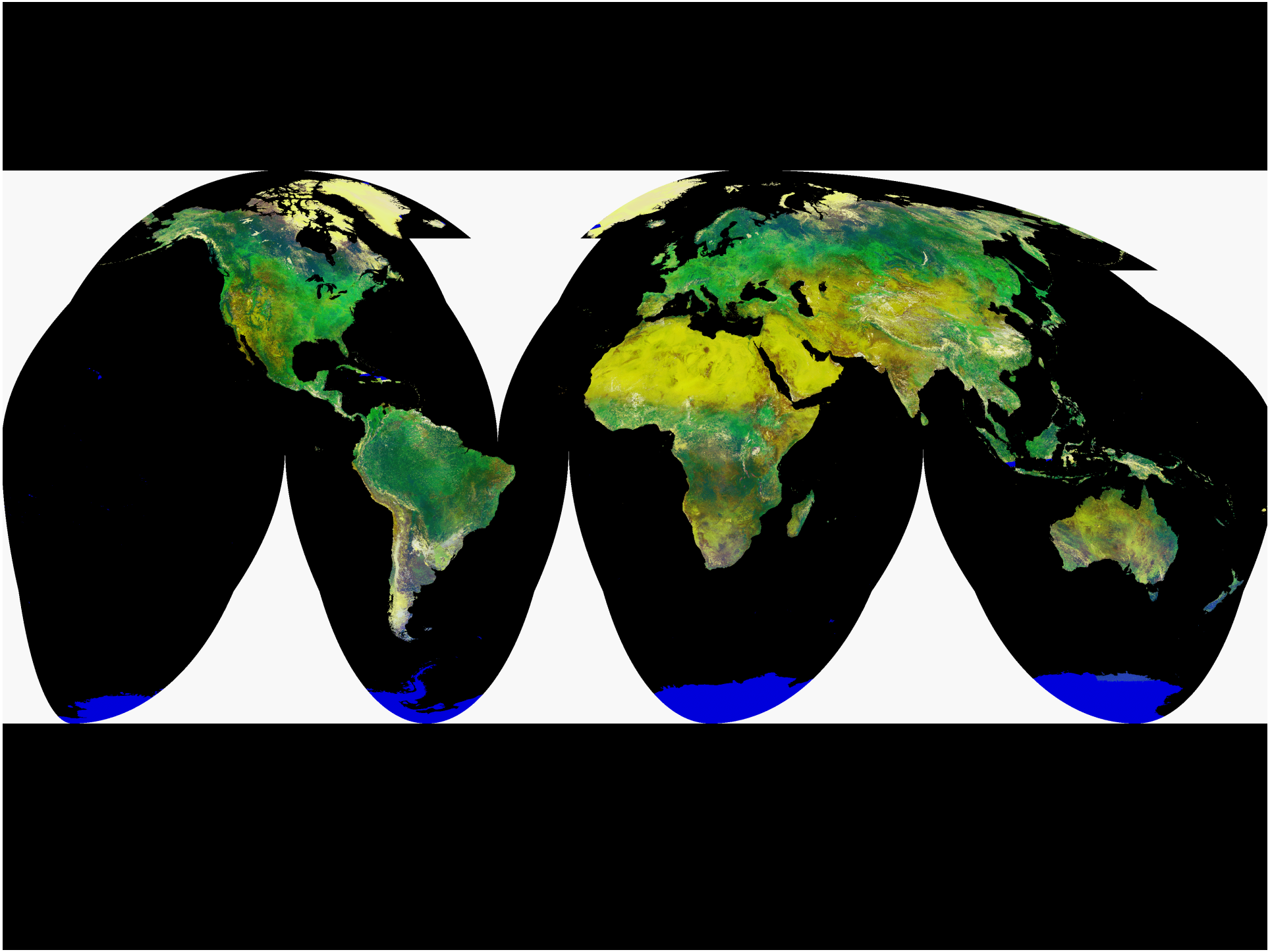
- Light
- Temperature
- Nutrients
- Water availability
- Temperature
- Carbon dioxide (plants)
- Oxygen (animals)

Characterizing broad ecological patterns

BIOMES

classifies geographic regions according to similarity in climate & dominant plant species

- similar climates tend to have organisms with similar adaptations (parallel/convergent evolution)
- Based 1° on terrestrial plant communities (temperature & precipitation as key factors)
- **Whittaker's** biome classification:
  - Average Temperature vs. Average Precipitation



Tropical Savannah

Serengeti NP

Temperate Desert

Potholes, E. WA

Alpine

Coast Range Mtns. BC

Tundra

S Central AK

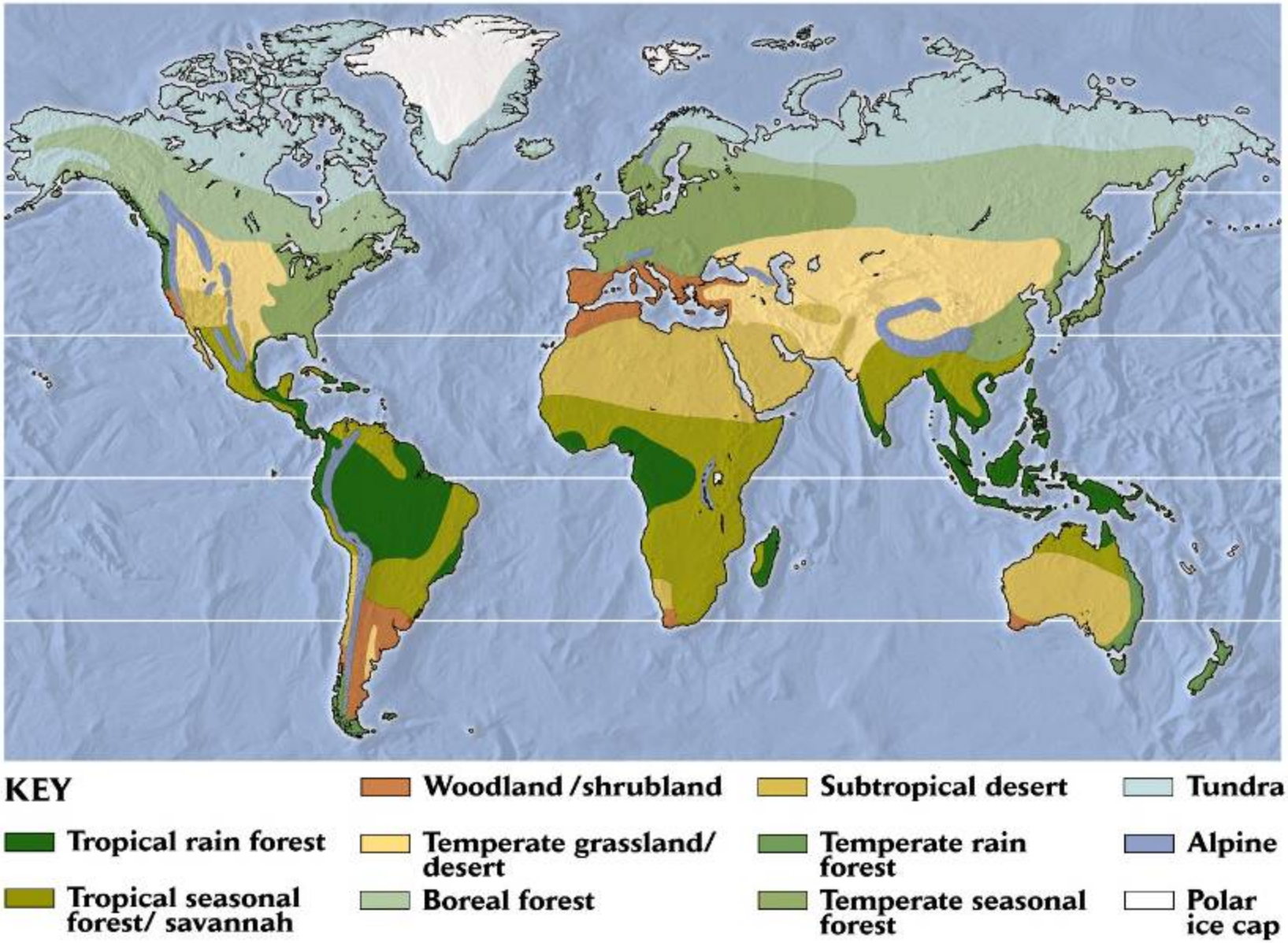
Tropical Rainforest

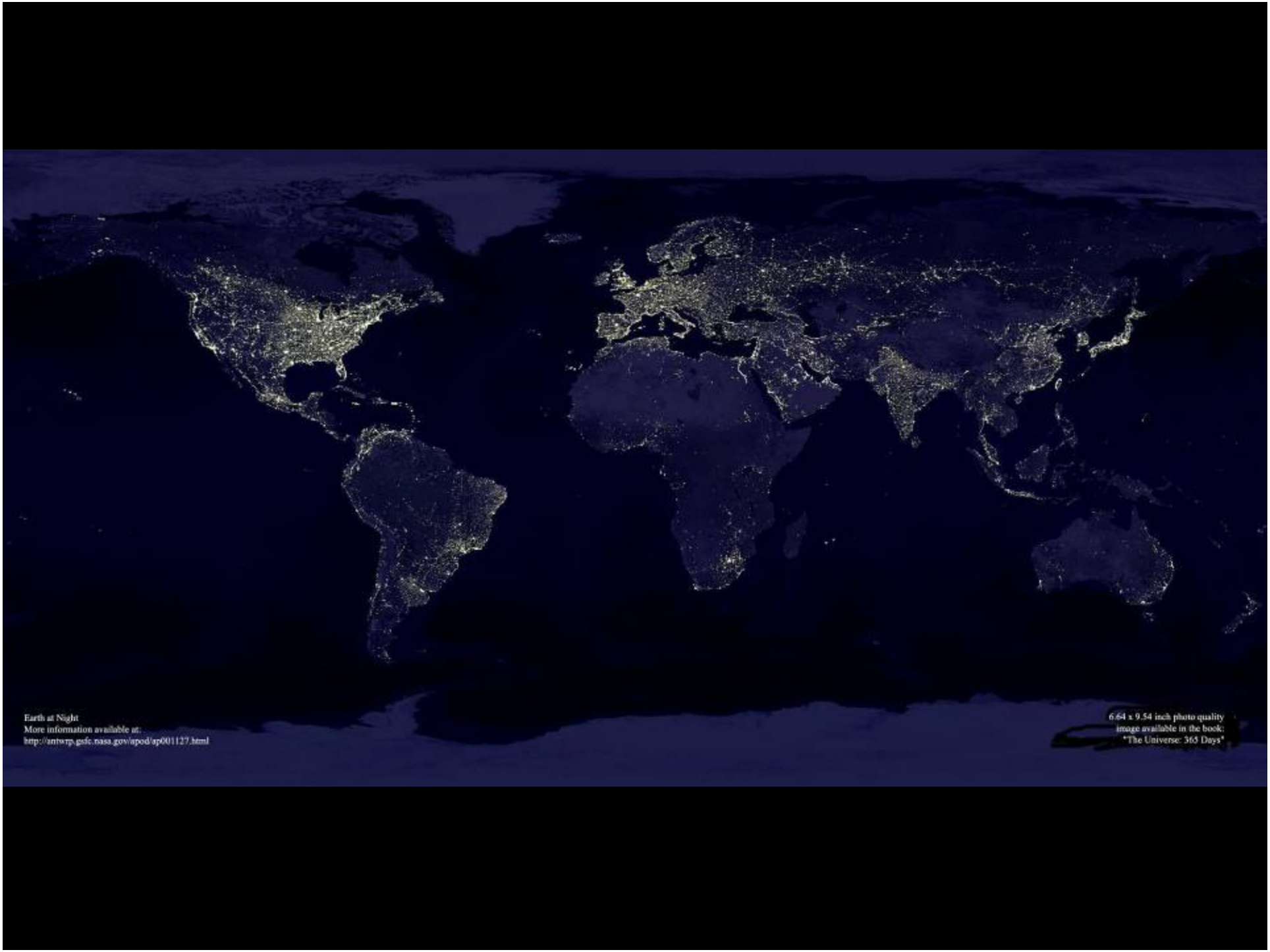
La Selva, Costa Rica

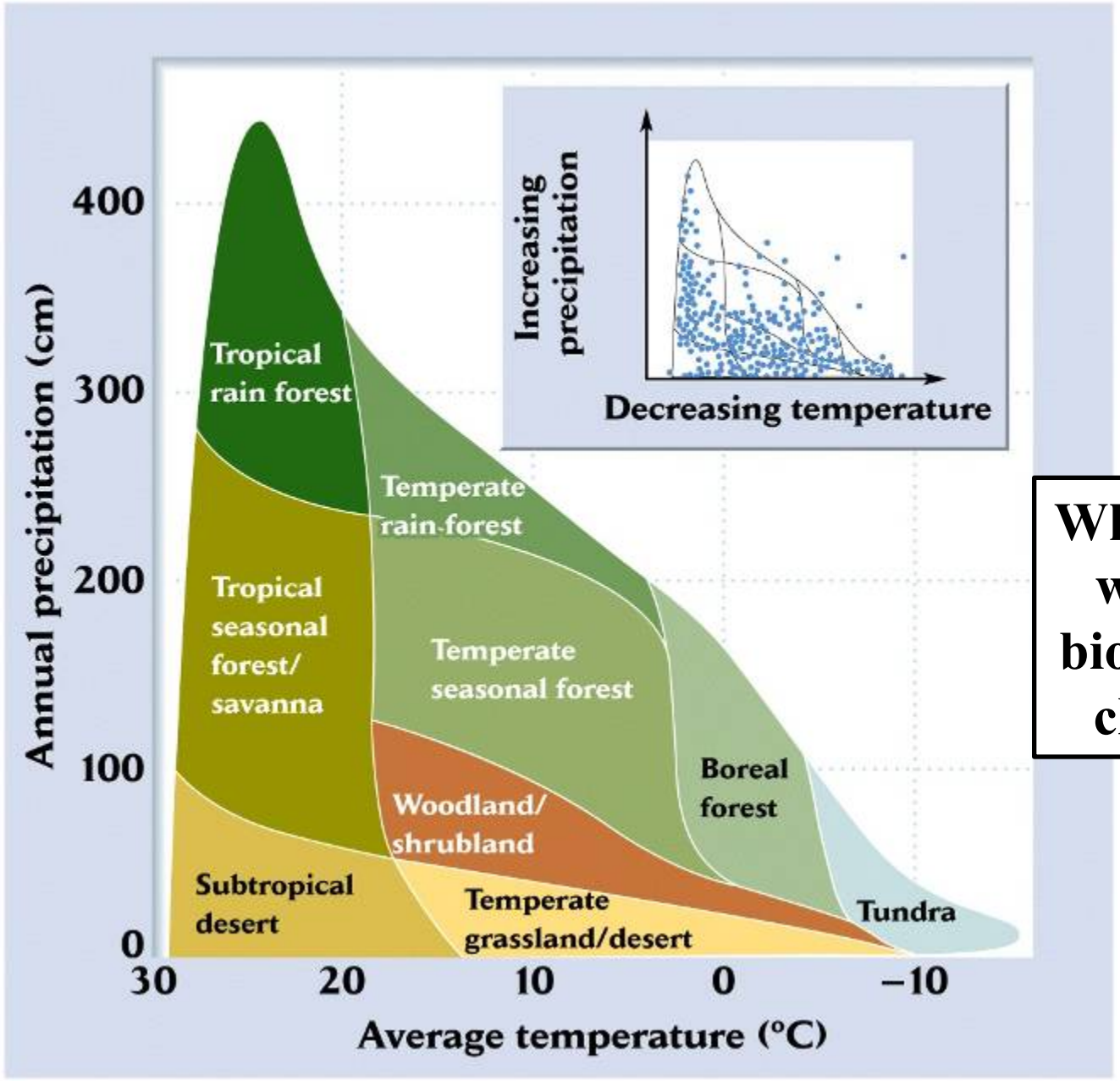
Temperate Seasonal Forest

New England

Major Biomes




Earth at Night
More information available at:
http://antwrp.gsfc.nasa.gov/apod/ap001127.html
6.64 x 9.54 inch photo quality
image available in the book:
"The Universe: 365 Days"



What will happen to where particular biomes are found as climate changes?

Characterizing broad ecological patterns

BIOMES

Limitations?

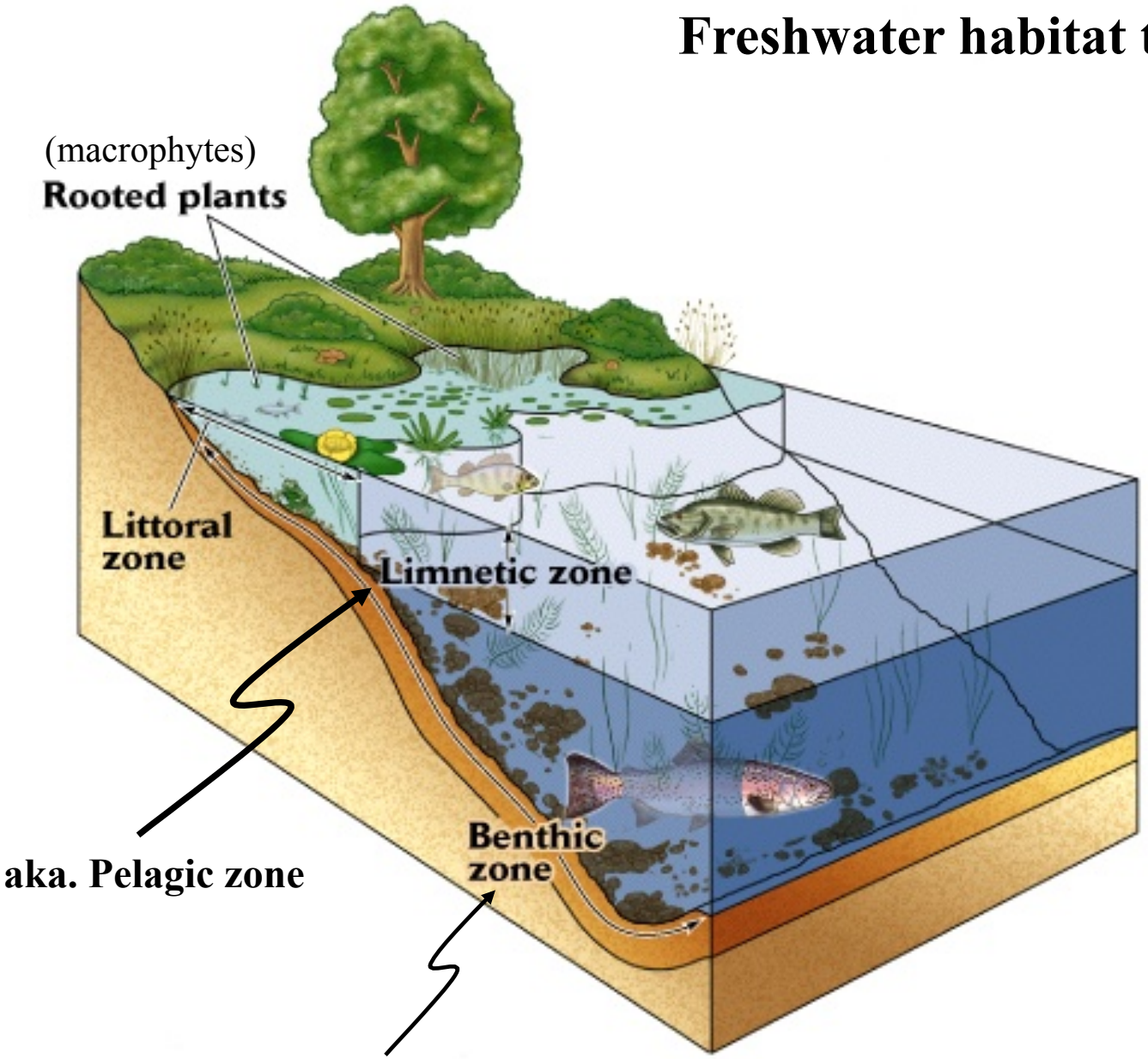
- What else might affect plant communities?

Soils, consumers, disturbance (fires), topography

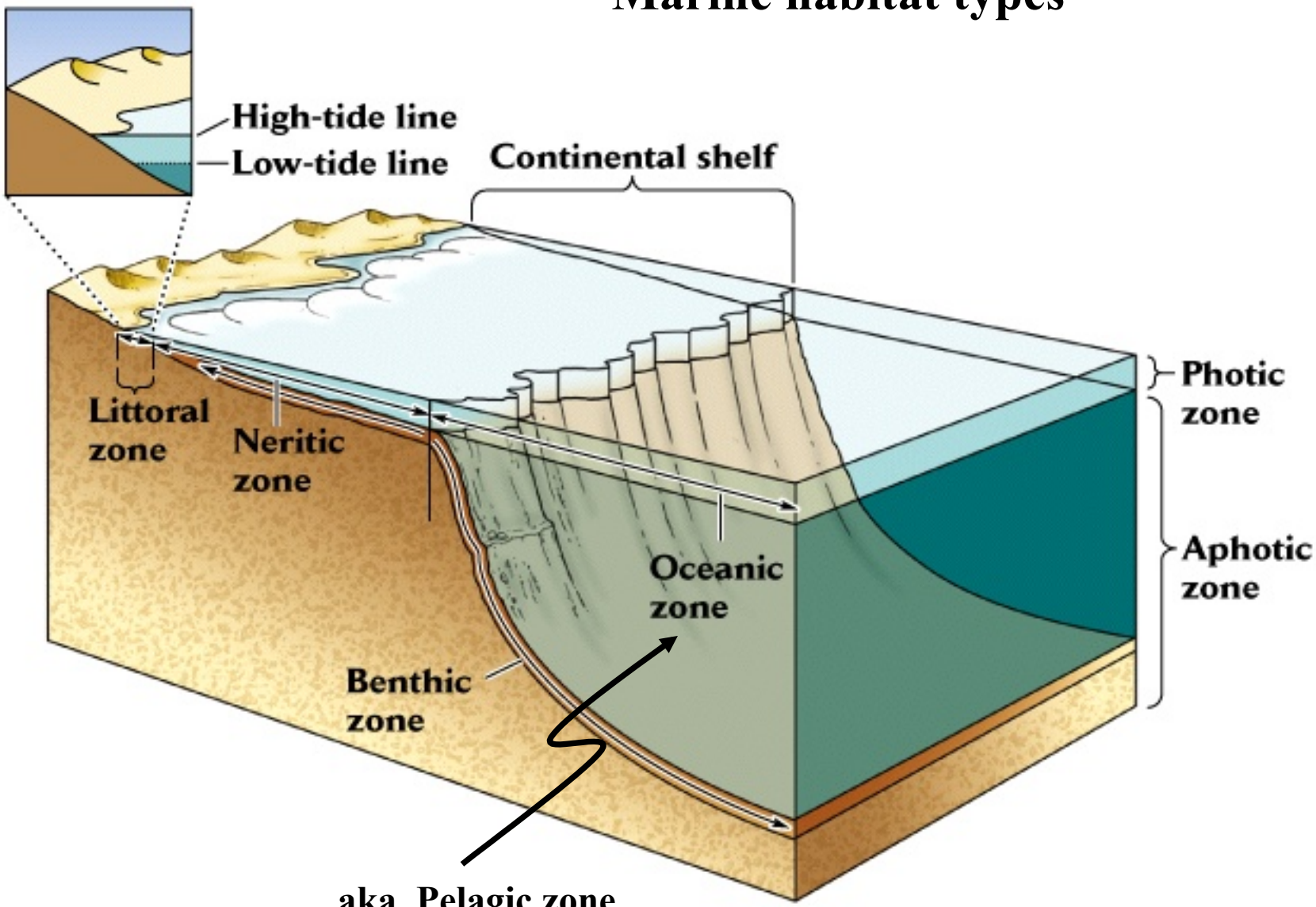
- Doesn't directly relate to Aquatic Ecosystems (algae/phytoplankton = dominant 'plant' type)

- Does describe major climate features important for both terrestrial and aquatic organisms alike

Freshwater habitat types



Marine habitat types



End of Physical Environment lecture

Next Tues: Study design

Next Thurs: 1st in-class exercise