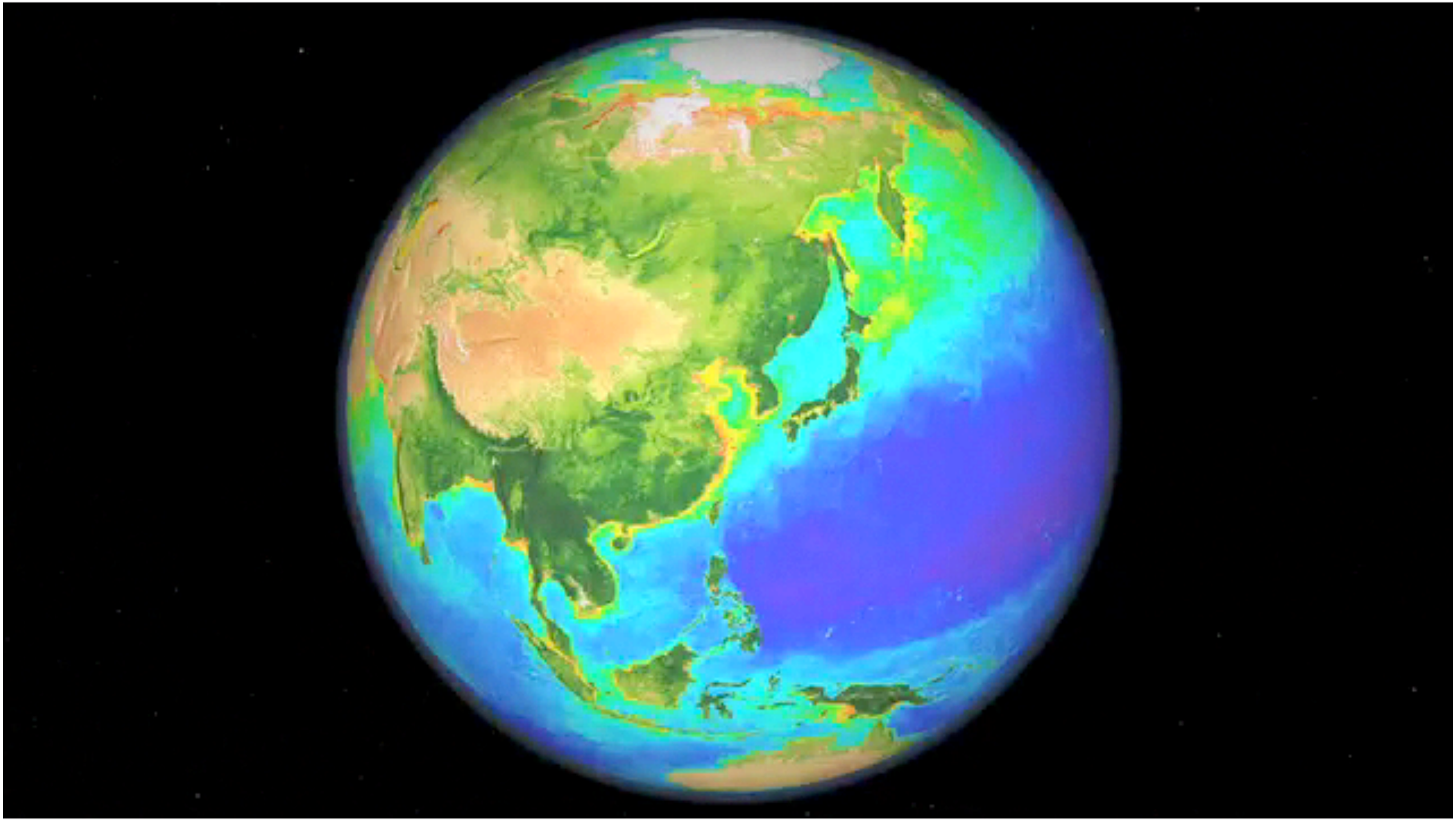
Chapter 52 (Campbell)
An Introduction to Ecology and the Biosphere

(52) Ecology/Biosphere

I.

Main Idea: Climate influences distribution of organisms
Main Idea: Climate Varies by latitude

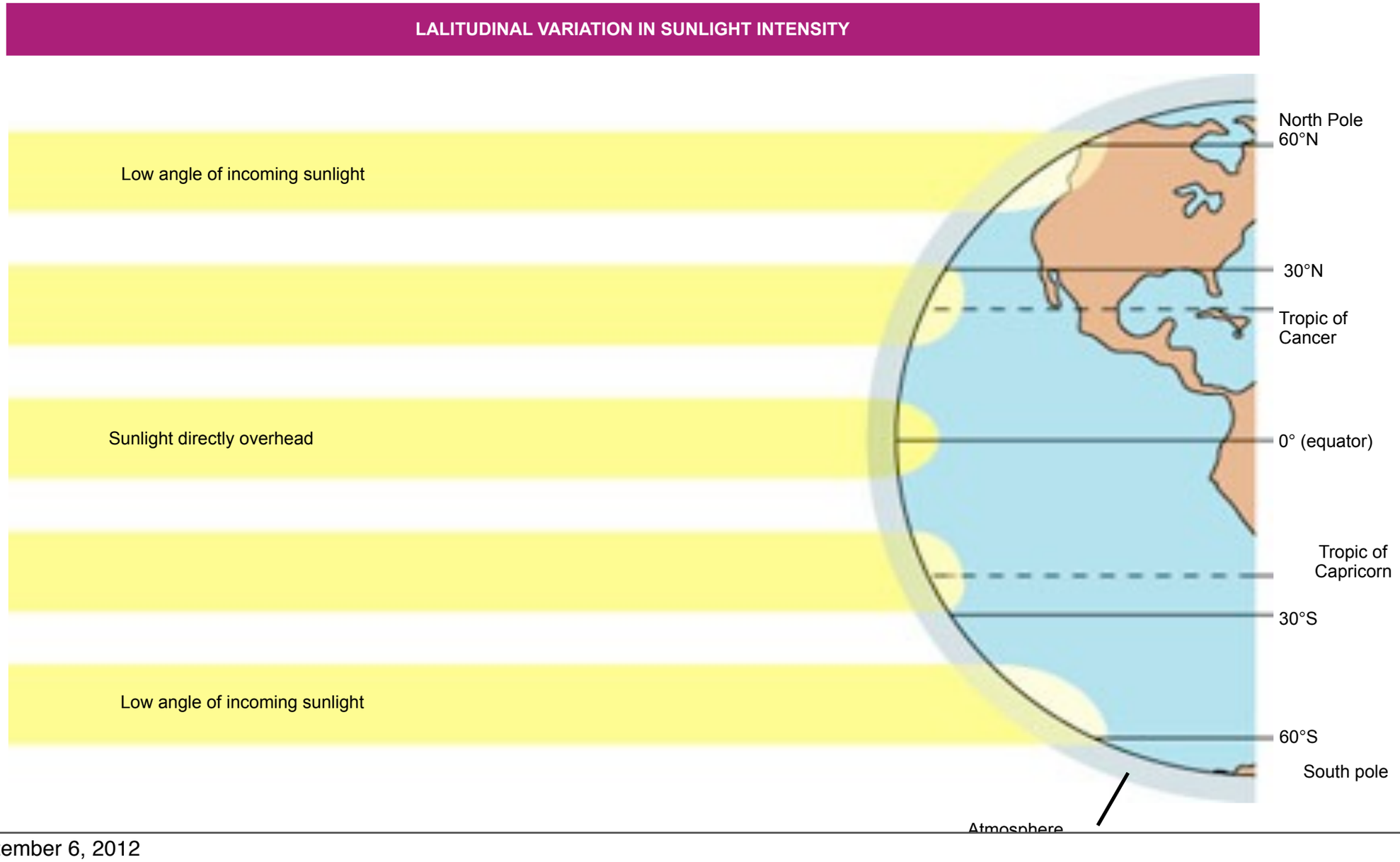
Can you give any examples of organisms distributed by latitude?

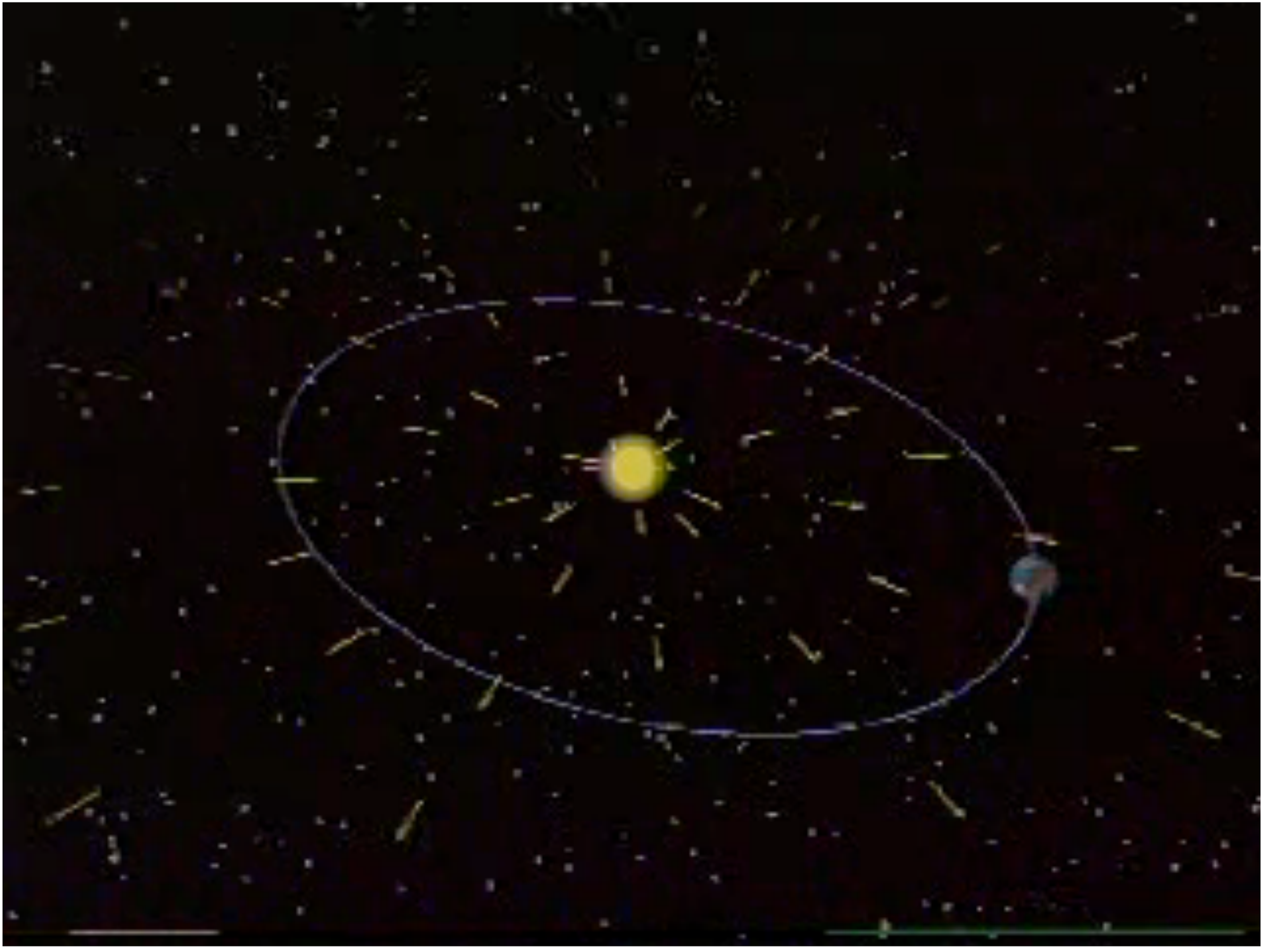


CLIMATE VARIATION & CHANGE

A. Latitude and Sunlight

- intensity of sunlight decreases as you move from equator to the poles





A. Latitude and Sunlight

- intensity of sunlight decreases as you move from equator to the poles

Equator (a)

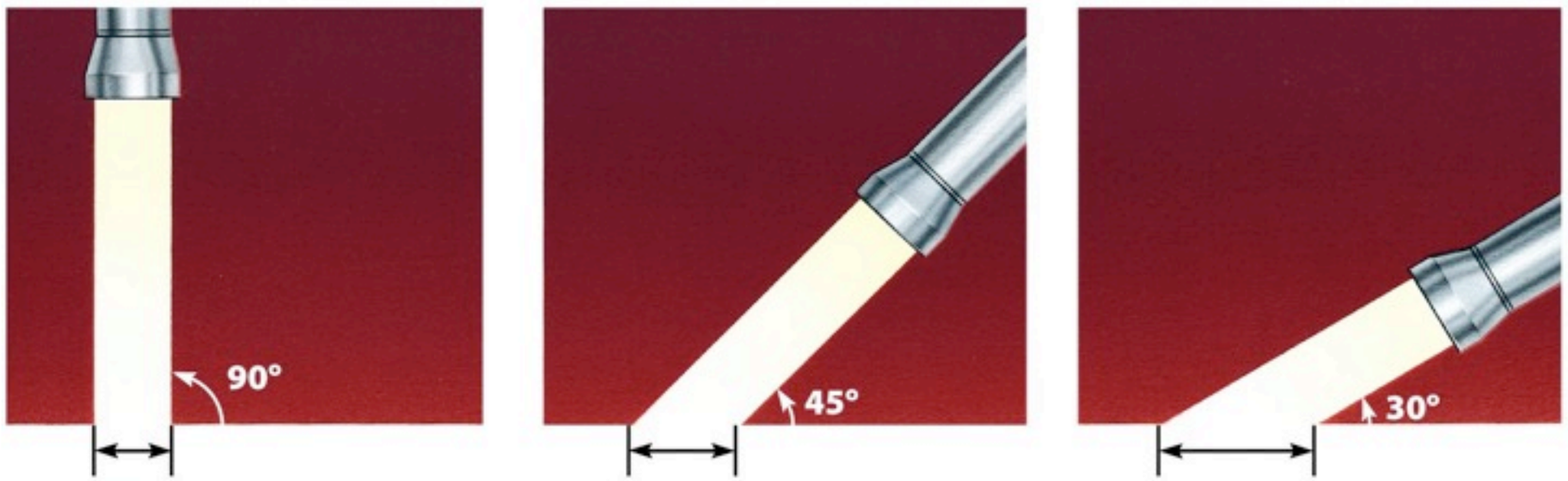
High concentration
Little Reflection High
Temperature

From (a) to (c)

In diagram below

Closer to Poles (c)

Low concentration
Higher Reflection
Low Temperature



1 unit of surface area

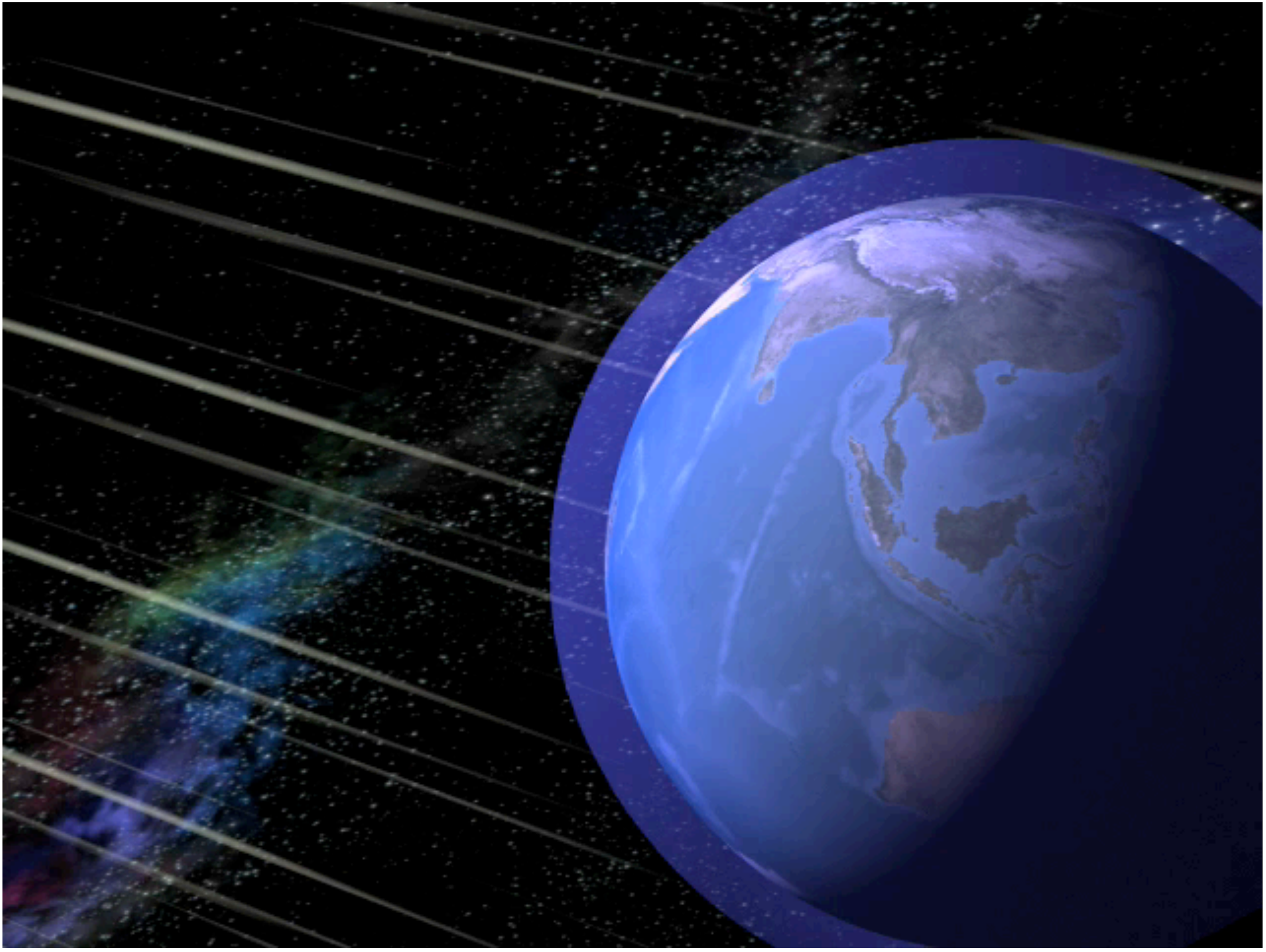
(a) One unit of light is concentrated over one unit of surface area.

1.4 units of surface area

(b) One unit of light is dispersed over 1.4 units of surface area.

2 units of surface area

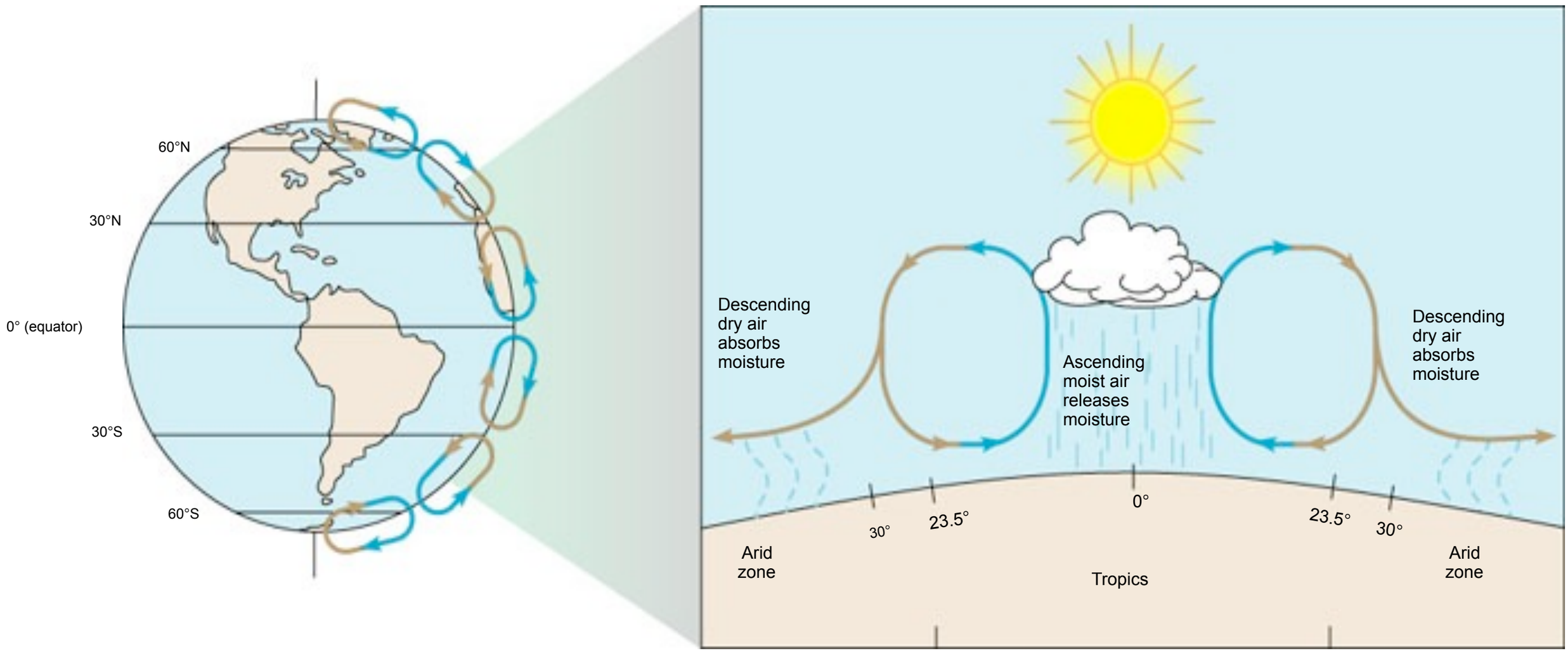
(c) One unit of light is dispersed over 2 units of surface area.



B. Global Wind & Rain

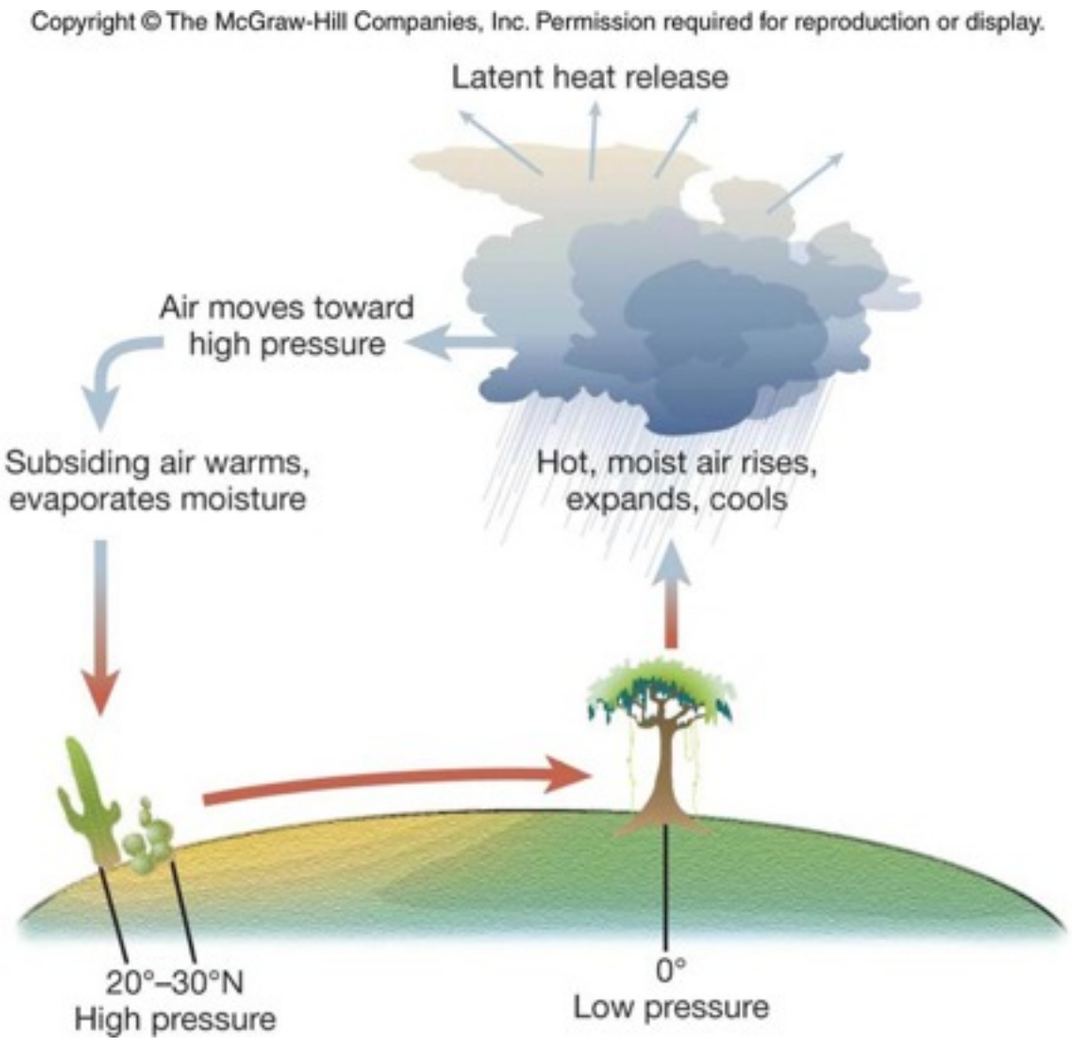
- hot air rises and cool air falls
- dry air absorbs water (higher rate of evaporation)

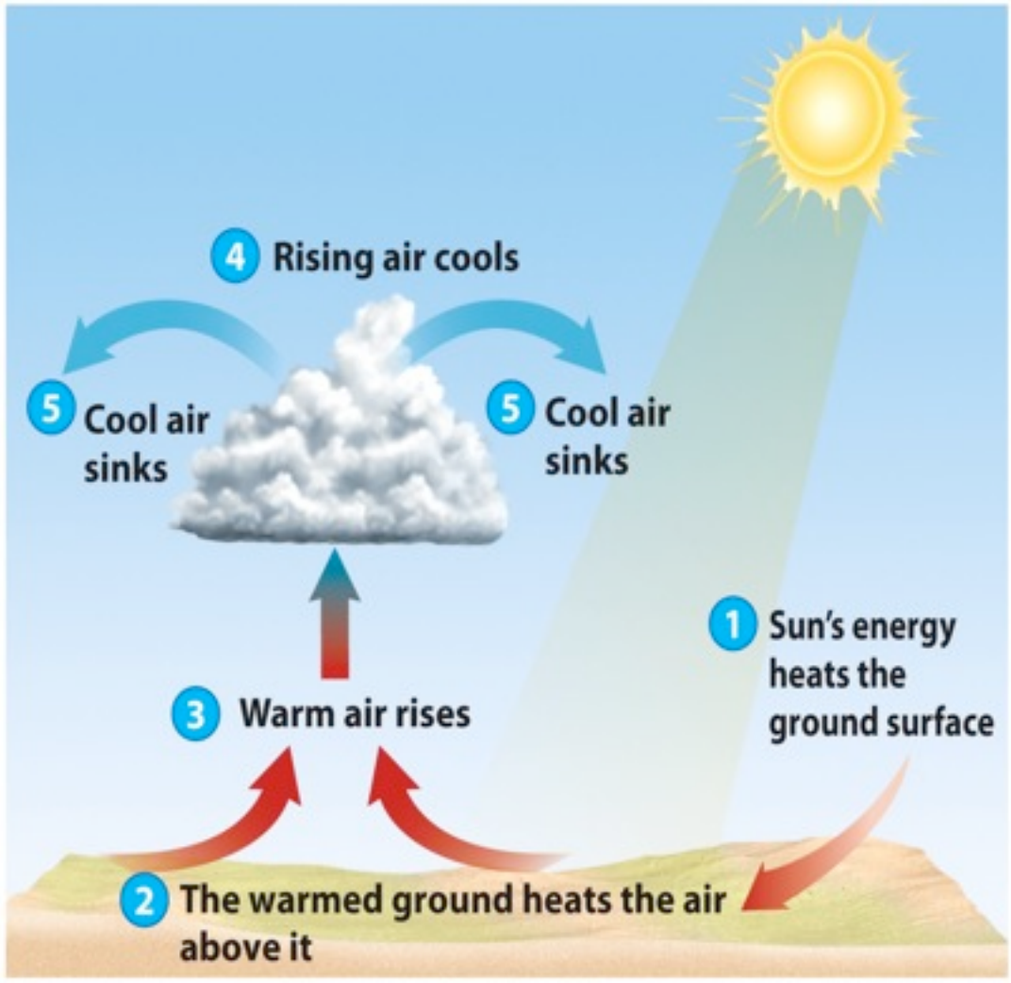
GLOBAL AIR CIRCULATION AND PRECIPITATION PATTERNS



B. Global Wind & Rain Patterns

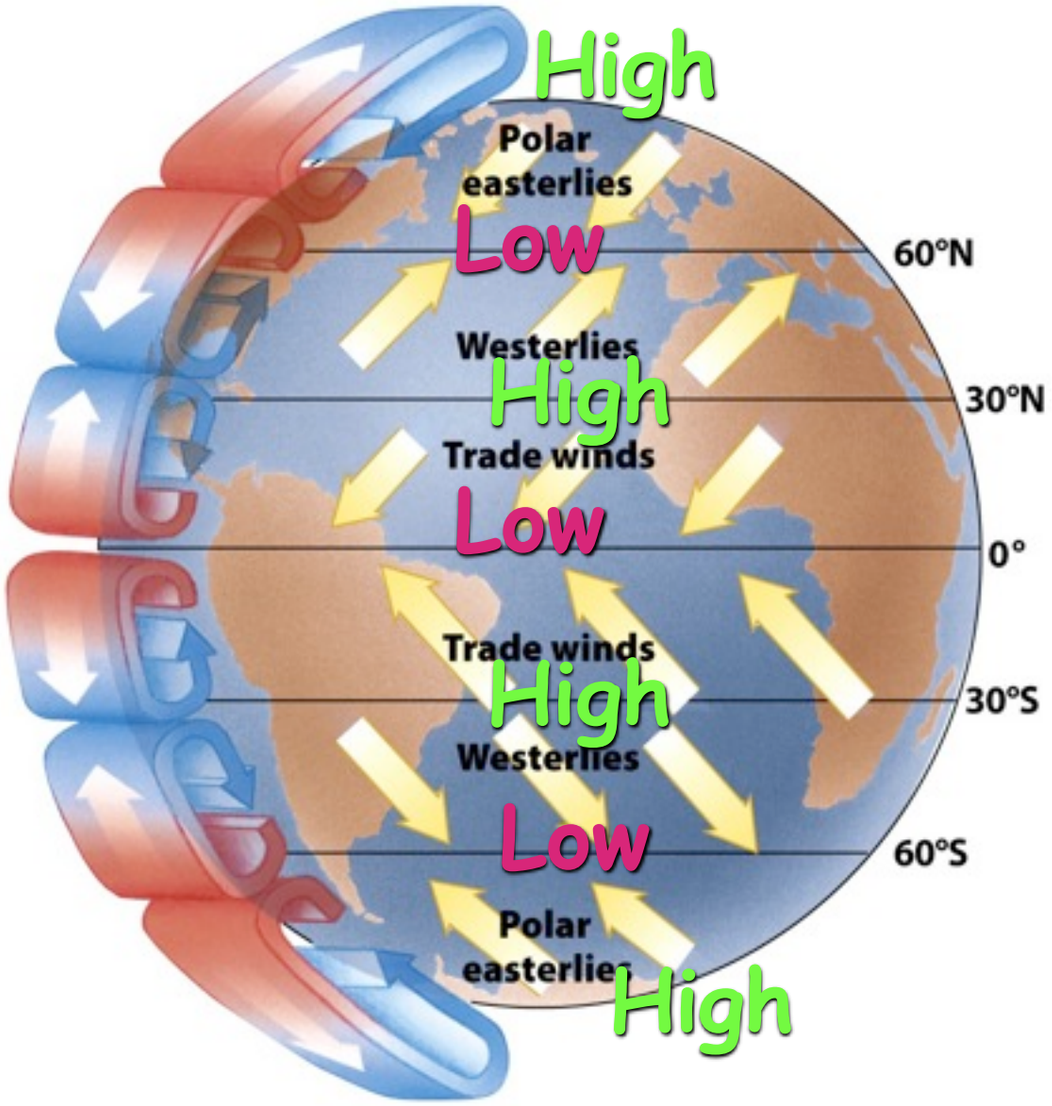
- hot air rises and cool air falls
- dry air absorbs water (higher rate of evaporation)

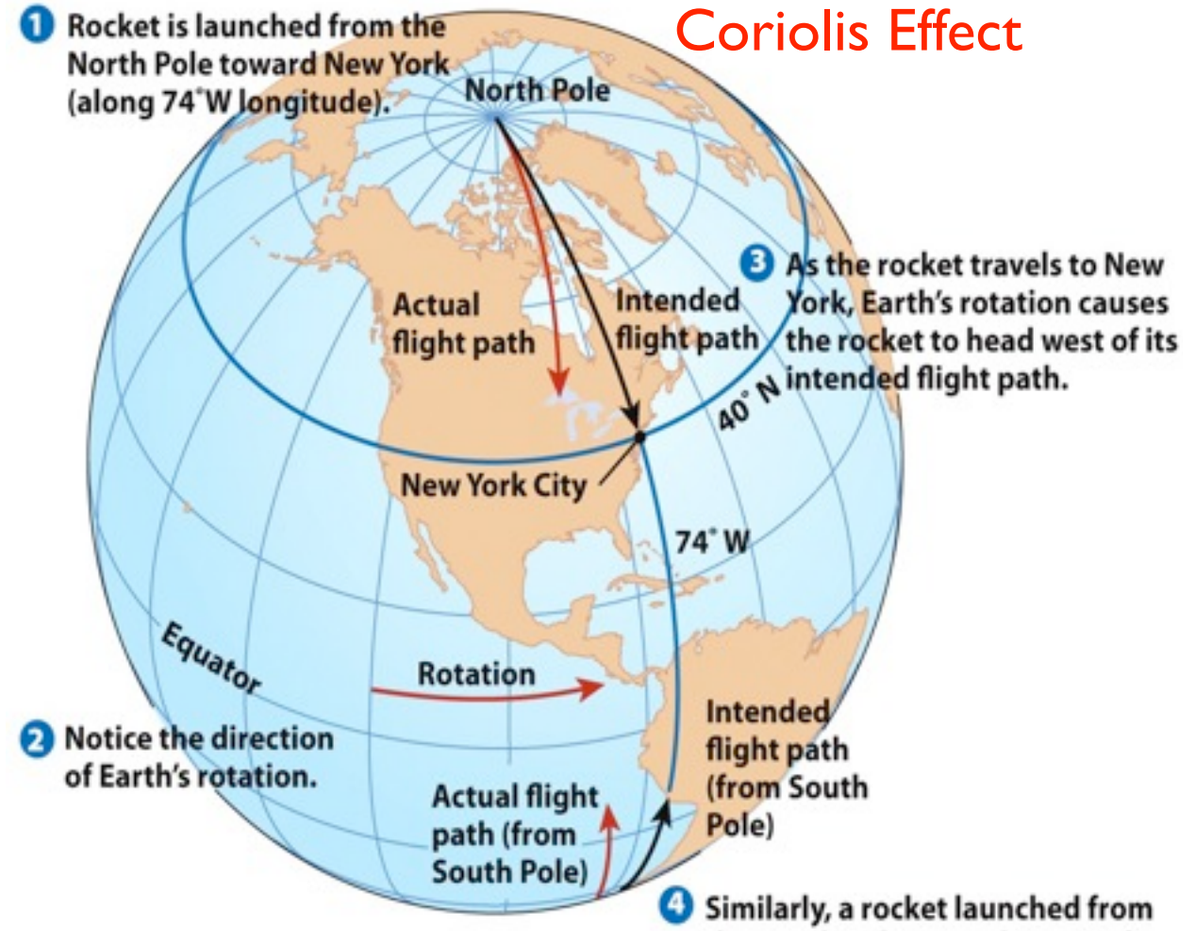




B. Global Wind & Rain Patterns

- hot air rises and cool air falls
- dry air absorbs water (higher rate of evaporation)





B. Global Wind & Rain Patterns

- the rotating earth + the rising and falling air = pattern seen below
  - (note: the land at the equator is moving faster than the land at the poles causing a deflection in the air)

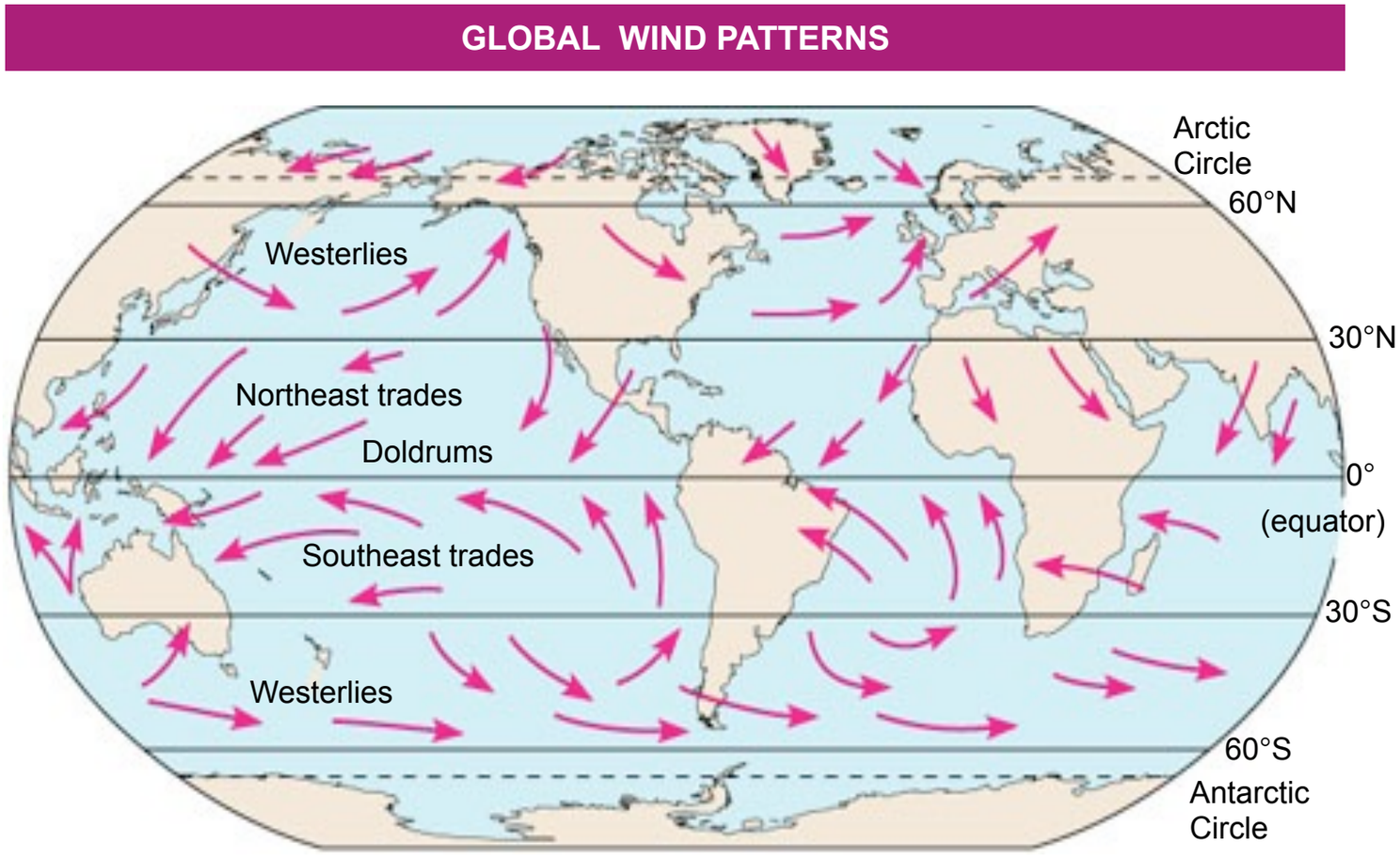
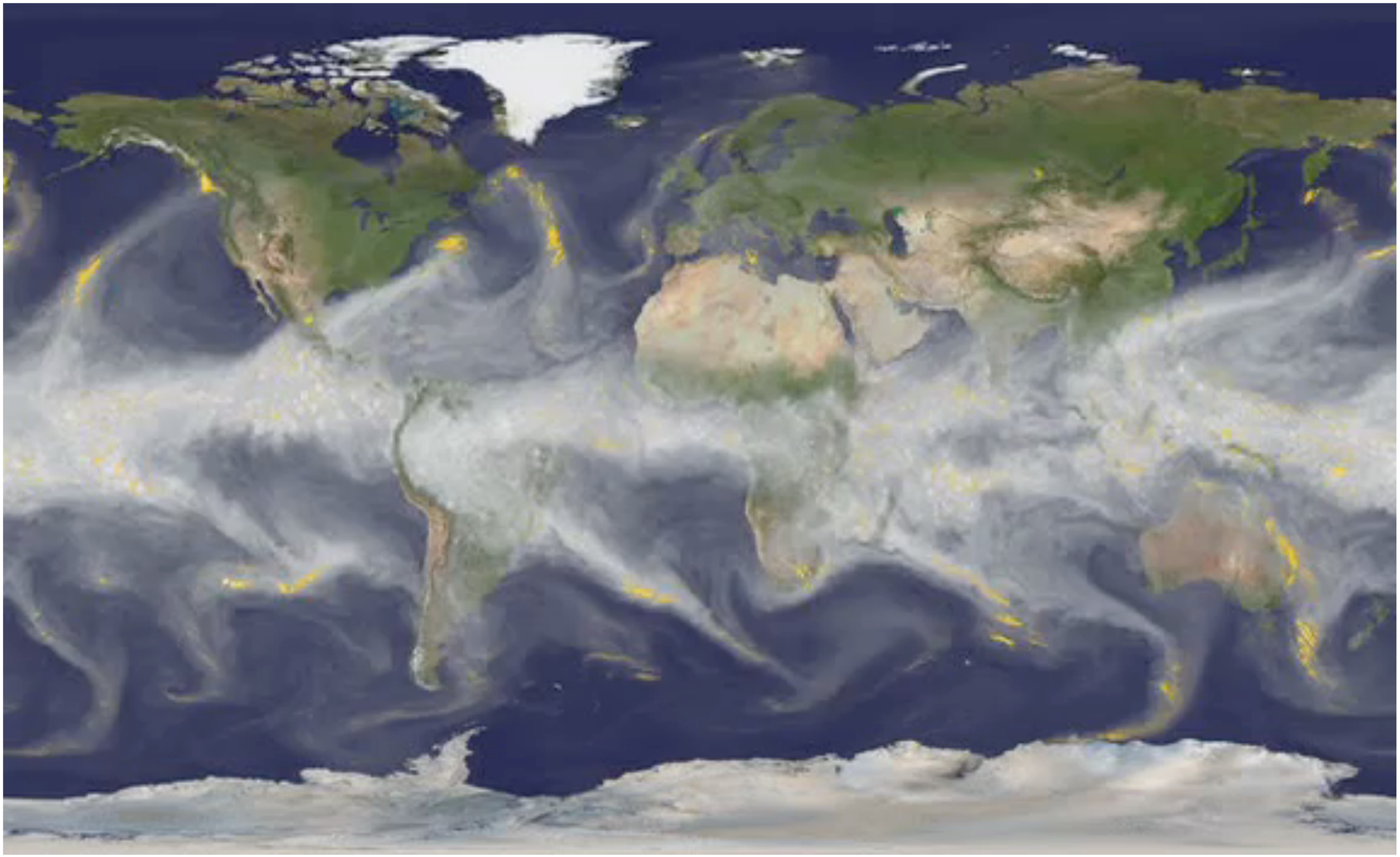


Figure 50.10



Can you name that tune?

Jimi Hendrix The wind cries Mary

Bottom Line!

Some Latitudes are warmer/cooler than others!
Some Latitudes are drier/wetter than others!

You have already learned or will learn that ***temperature*** and ***water*** are most important abiotic factors for terrestrial life and this explains the connection between latitude and the distribution of life on this planet.

C. Global Climate Patterns

- The Sun is ultimately responsible for global climate patterns
- The heat from the sun (and the earth's rotation) create the wind, rain and temperature patterns of earth

D. Regional & Local Climate

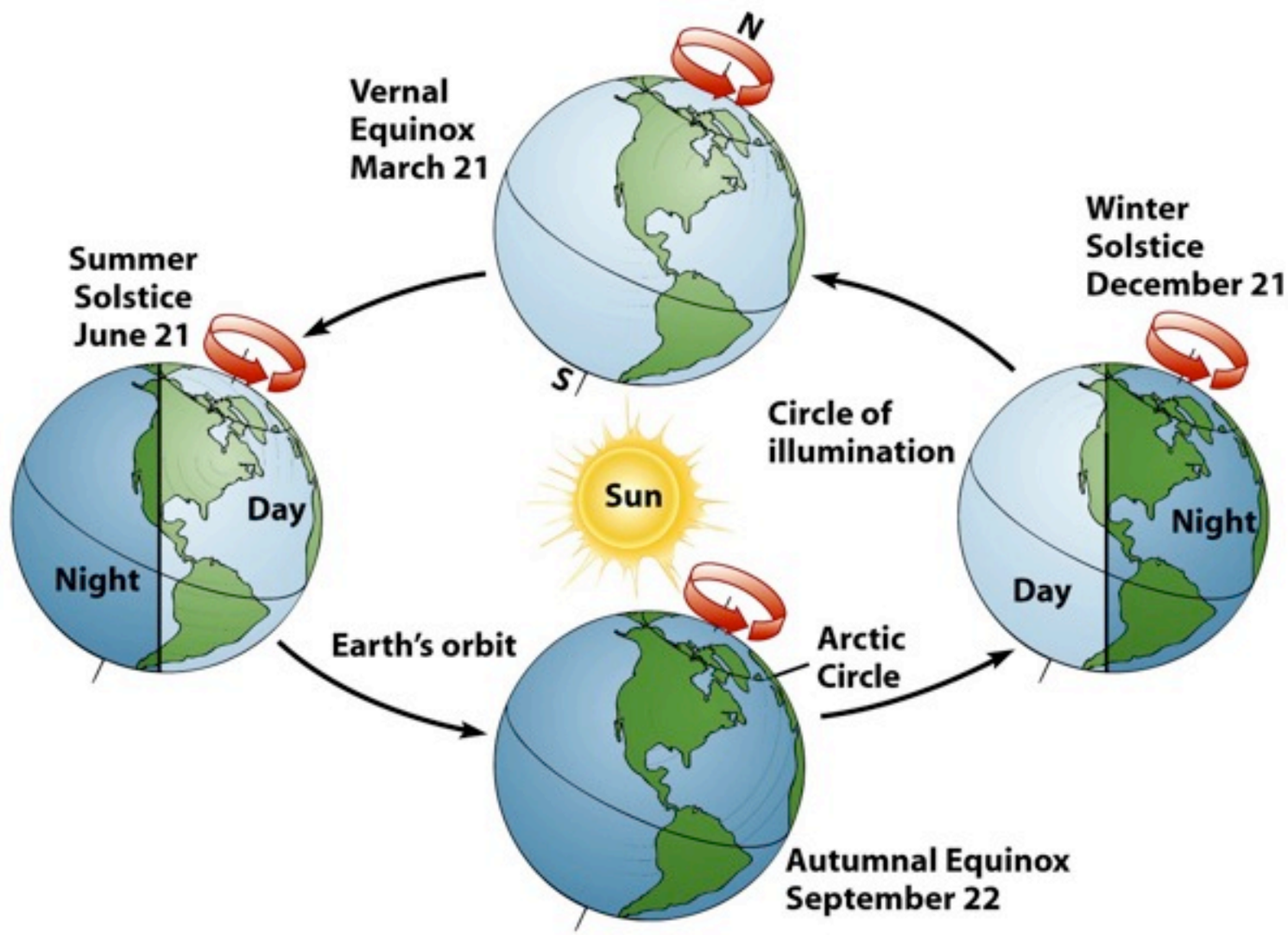
- At the same or similar latitudes climate can differ from one place to another
- At the same or similar latitudes climate can vary over time
  - There are a variety of reasons for these variation
    - tilt of the earth on its axis, large bodies of water, mountains and an infinite number of other factors like fallen trees, caves etc

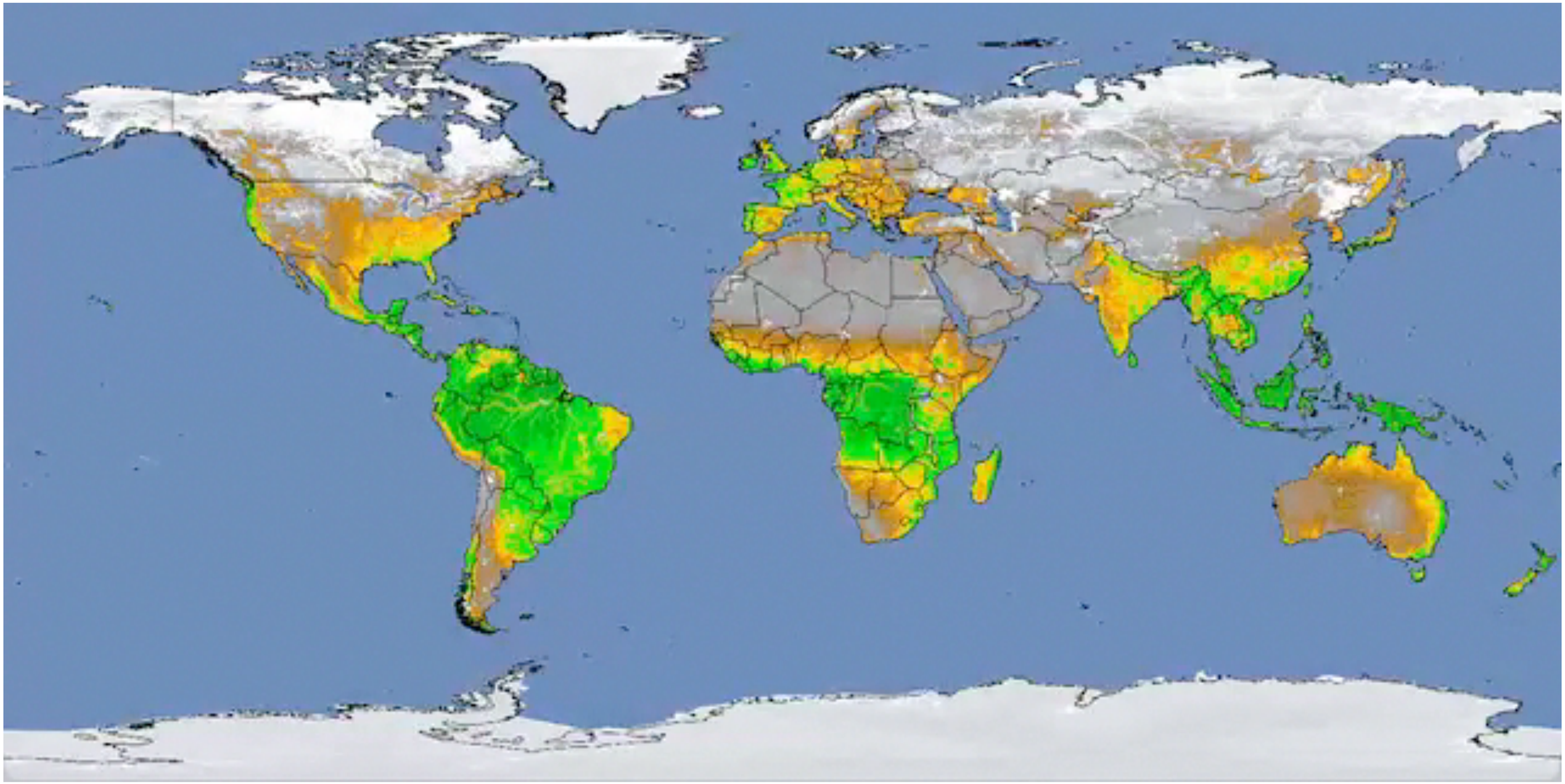
1. seasons

- Earth is tilted on its axis
- Earth Rotates around the sun over 365.25 days
- Therefore some parts of the Earth receive more or less sunlight over the course of the year
    - *Remember Sunlight is the "climate's engine" changing its intensity will also change wind & rain patterns, ocean currents, temperature, and length of daylight*
    - *June 21st...24 hrs of light in Arctic and 24 darkness in Antarctica by December 21st the reverse is true in both locations*
    - *Rainy season in Cairns, Australia from Jan-Mar and little to no rain from July-Sept*

I. seasons

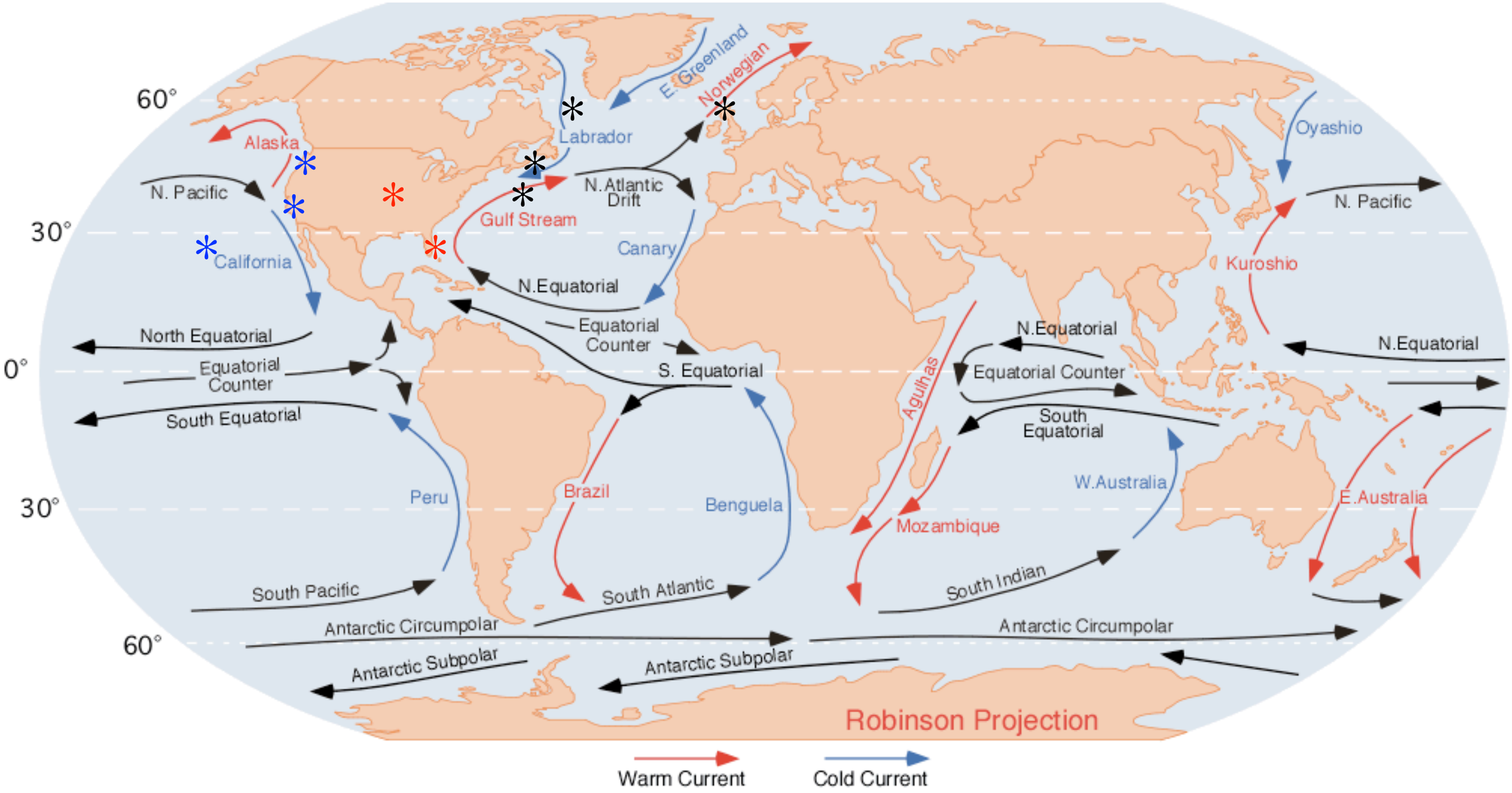
SEASONAL VARIATION IN SUNLIGHT INTENSITY





2. Large Bodies of Water

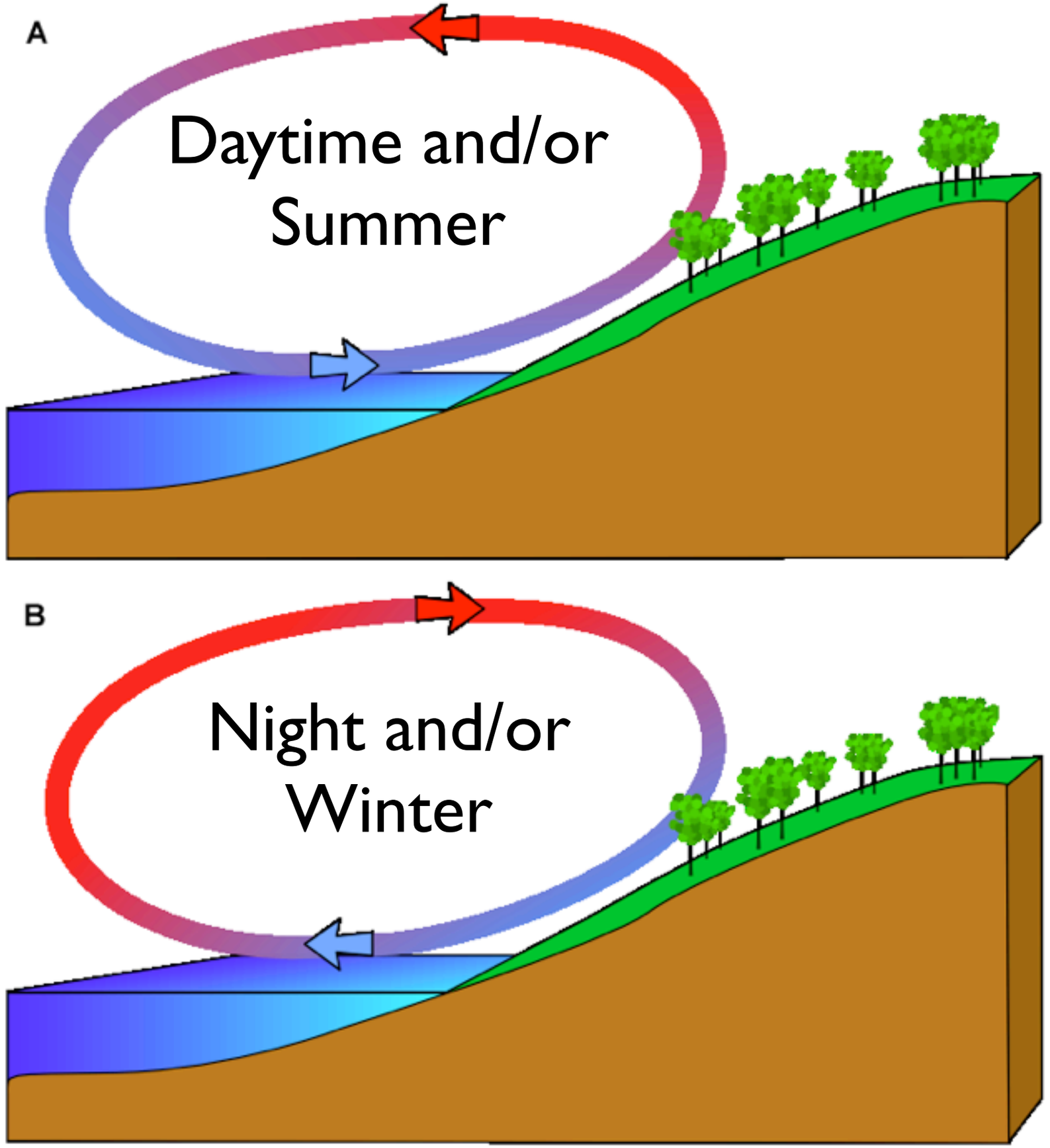
- * Ocean currents can heat or cool land masses
- * Large bodies of water can moderate land temps.
  - (review water's high specific heat)
- * Ocean currents can alter precipitation patterns
  - (see map for examples)


60°
30°
0°
30°
60°
Alaska
N. Pacific
California
North Equatorial
Equatorial Counter
South Equatorial
Peru
South Pacific
Antarctic Circumpolar
Antarctic Subpolar
Labrador
E. Greenland
Norwegian
N. Atlantic Drift
Gulf Stream
Canary
N.Equatorial
Equatorial Counter
S. Equatorial
Brazil
South Atlantic
Benguela
Agulhas
Mozambique
South Indian
Antarctic Circumpolar
Antarctic Subpolar
Oyashio
N. Pacific
Kuroshio
N.Equatorial
N.Equatorial
Equatorial Counter
South Equatorial
W.Australia
E.Australia
Robinson Projection
Warm Current
Cold Current

Thursday, September 6, 2012

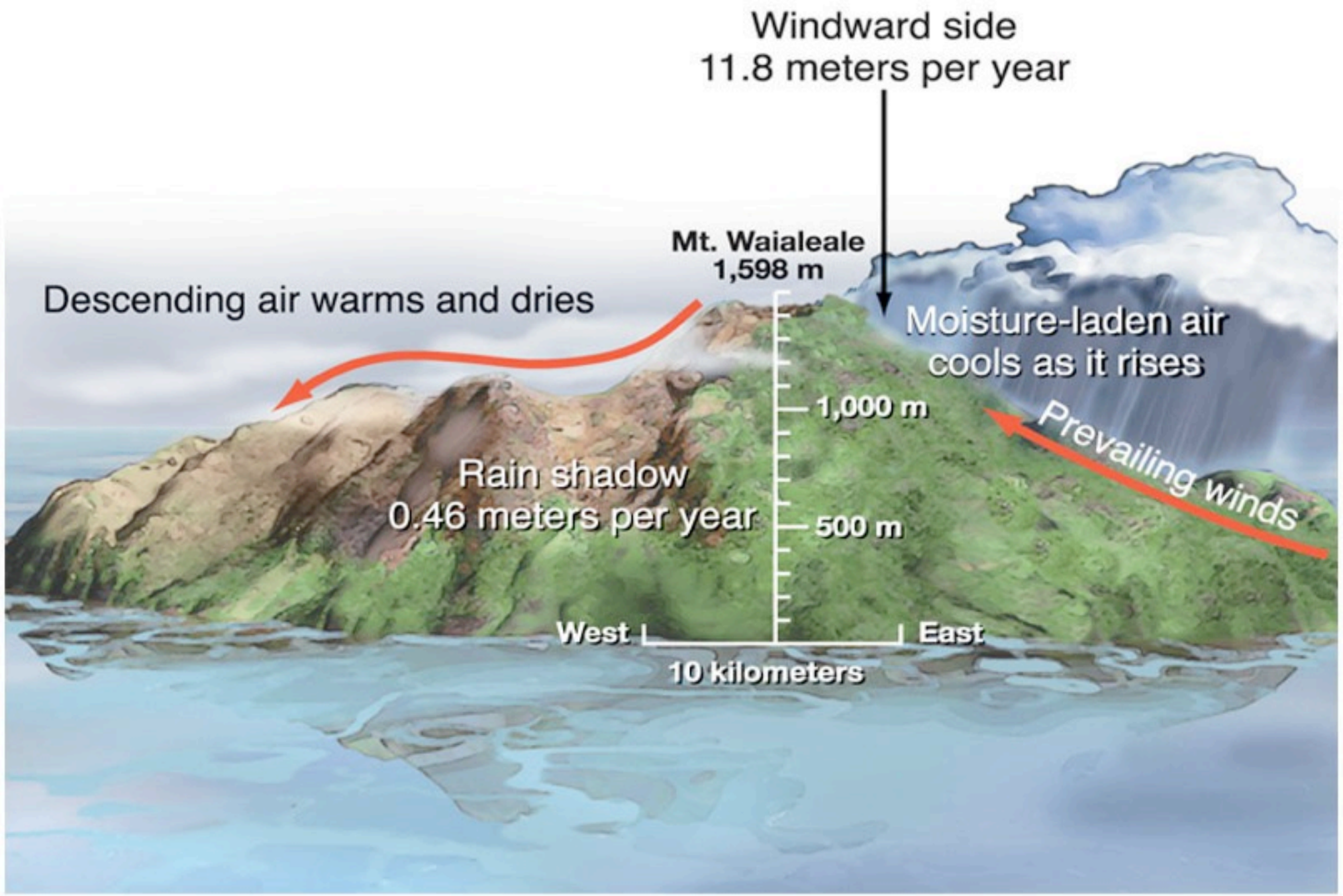
Thursday, September 6, 2012

Thursday, September 6, 2012


A
Daytime and/or
Summer
B
Night and/or
Winter

3. Mountains & Water

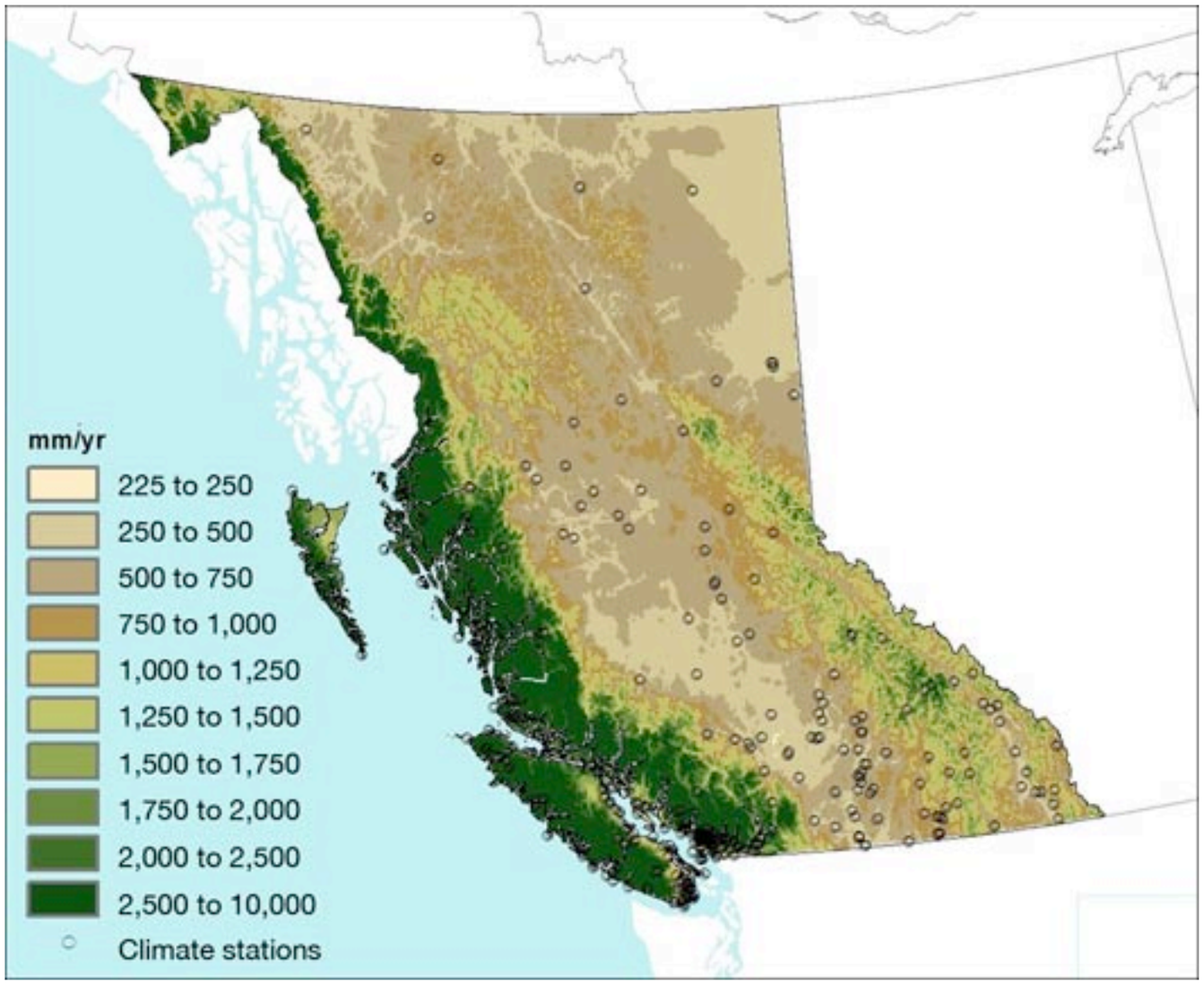
- "Rainshadows"



3. Mountains & Water

- "Rainshadows"

Annual Precipation in British Columbia




Death Valley


Idaho
Oregon
Nevada
California

4. Mountains

- mountains can affect the amount and intensity of light thus they can alter *temperatures* and *precipitation* patterns

How can mountains affect temperature?

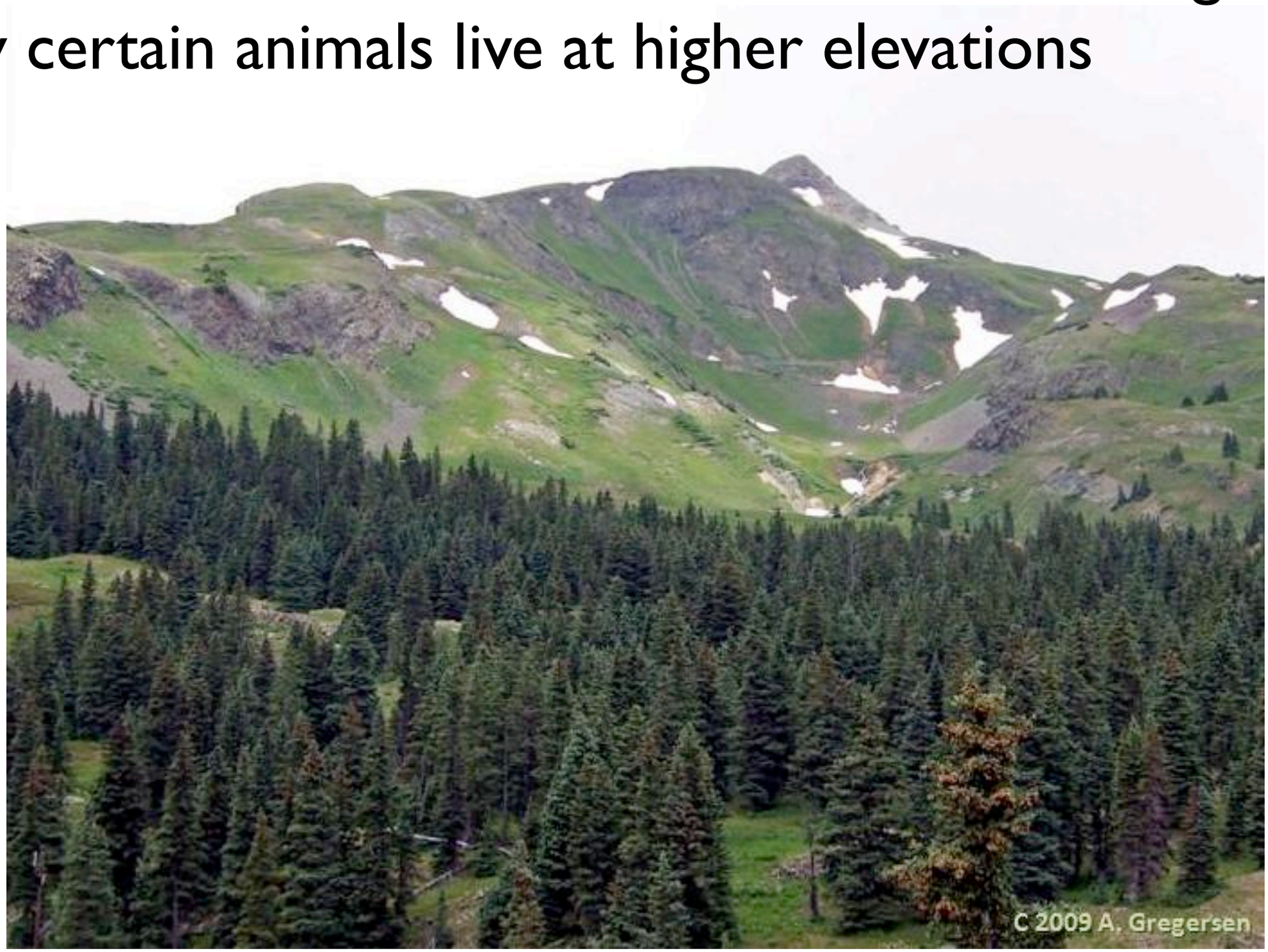
Answer: for every 1000m in elevation gain there is a 6 degree Celcius decrease in temperature (~13 degrees F)

Will this effect the distribution of organisms on the mountain?

Answer: Absolutely, see illustration

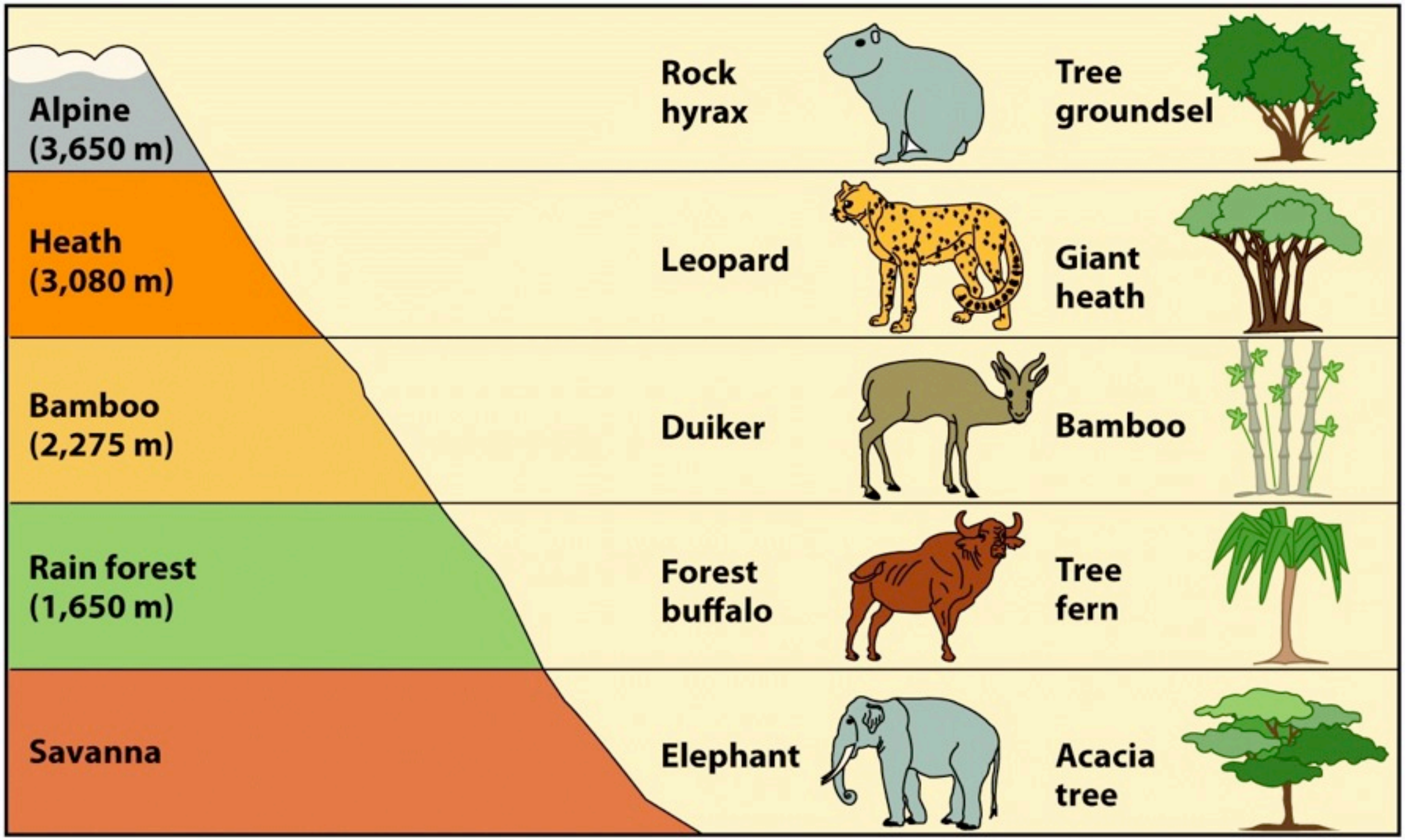
4. Mountains

Notice the tree line in Colorado, like certain vegetation only certain animals live at higher elevations



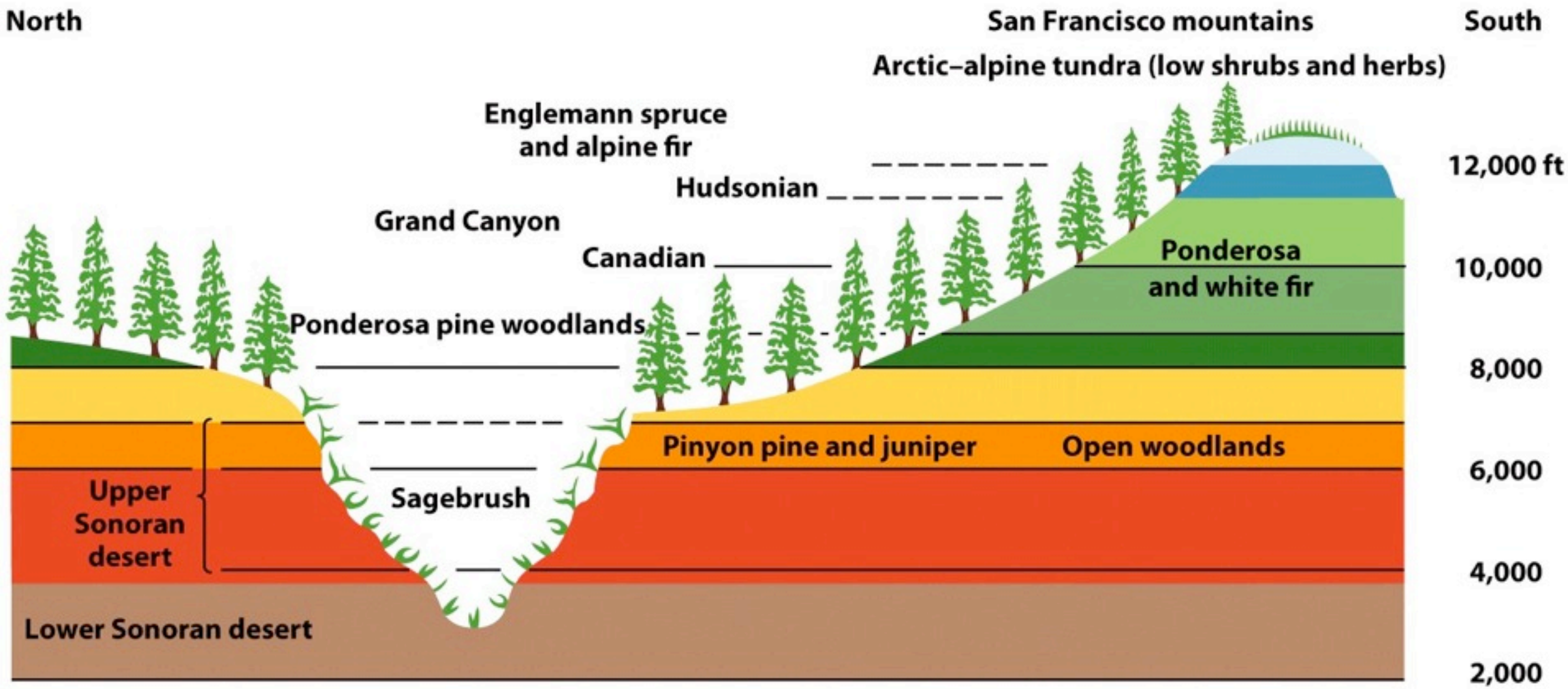
4. Mountains

Below is another example illustrating the changing flora with elevation gain



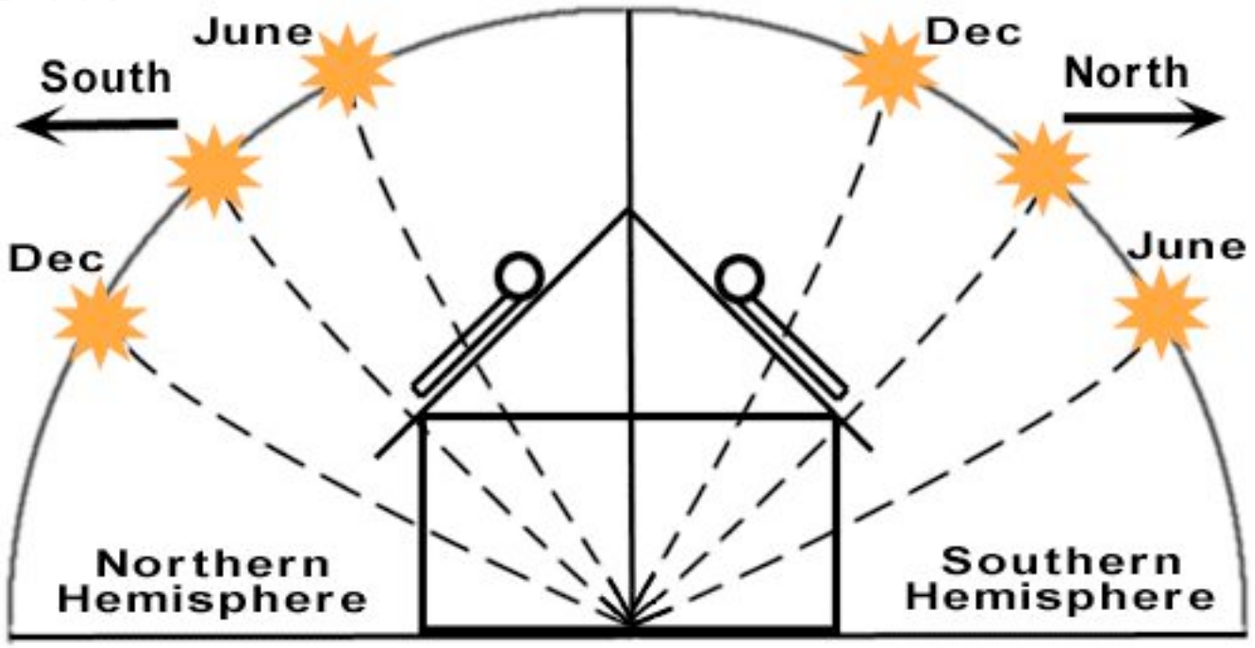
4. Mountains

Below is another example illustrating the changing flora with elevation gain



4. Mountains

Compare the north and south facing slopes on the mountains below.



Which side will get more light?

Be warmer? More water?

Answer: in northern hemisphere the south facing

Answer : south slope, north slope

Would you expect the organisms to differ on each side?

Answer: Absolutely

4. Mountains

- compare the north and south facing slopes of a mountain range in the northern hemisphere

Conifers typically grow on north face where shrubby drought resistant plants grow on the south face

E. MicroClimate

- Climate can vary within small distances due to local features
- Compare the following & Consider abiotic factors such as water, light, temperature & wind differences in each
  - below a fallen tree in a forest vs above the tree
  - under the canopy in a forest vs just outside the canopy
  - inside a cave vs outside
- Can you think of another local feature?

Note: Abiotic factors effect biotic factors (life) and biotic factors can alter abiotic factors as well

Bottom Line!

Climate effects the distribution and abundance of life.

Climate can vary for a number of different reasons.

Life will flourish where temperatures are moderate and rainfall is abundant.

F. Global Climate Change

- Climate effects the distribution and abundance of organisms
- Change the climate...change both of these above
- **Altering these changes ecosystem dynamics and potentially the services they provide**
  - plants link us to the ultimate source of all energy...the sun!
  - autotrophs provide oxygen
  - wetlands filter water and buffer storm surge

Note: The scientific method! A hypothesis (possible explanation) leads to expected results (predictions) when actual results (data) match the expected results then we have support for our hypothesis. Global warming is no longer conjecture an abundance of evidence exists.


peak bloom
Feburary
March
April
May
spring

Table 4.1 Ecosystem Services

Ecosystem	*Services Provided by Ecosystem*
Forests	Purify air and water; produce and maintain soil; absorb carbon dioxide (carbon storage); provide wildlife habitat; provide humans with wood and recreation
Freshwater systems (rivers and streams, lakes, and groundwater)	Moderate water flow and mitigate floods; dilute and remove pollutants; provide wildlife habitat; provide humans with drinking and irrigation water, food, transportation corridors, electricity, and recreation
Grasslands	Purify air and water; produce and maintain soil; absorb carbon dioxide (carbon storage); provide wildlife habitat; provide humans with livestock and recreation
Coasts	Provide a buffer against storms; dilute and remove pollutants; provide wildlife habitat, including food and shelter for young marine species; provide humans with food, harbors, transportation routes, and recreation
Sustainable agricultural ecosystems*	Produce and maintain soil; absorb carbon dioxide (carbon storage); provide wildlife habitat for birds, insect pollinators, and soil organisms; provide humans with food and fiber crops

Ex. Mangroves & Indonesian Tsunami

*Sustainable agricultural ecosystems are human-made and therefore inherently different from other ecosystems. Sustainable agriculture is discussed in Chapter 19.
(Adapted from *Climate Change Impacts in the United States*)

F. Global Climate Change

- **The changing distribution of organisms is well documented and are all consistent with a warming world**
  - Over the last decade *Snow crab* have extended their 500 km to the north in search of colder water
  - *Marmots* in Colorado are emerging from hibernation 3 weeks earlier than in the 1970's
  - *Tree swallows* have advanced their egg laying by 9 days from 40 years ago
    - Countless more examples of animals extending their range north, flowers blooming earlier, migratory patterns changing, stunted growth in certain trees, tropical diseases spreading north, etc

F. Global Climate Change

- Most people do not understand the sensitivity of organisms and ecosystems to biotic and abiotic factors
  - Human blood pH is maintained between 7.35-7.45
  - El Nino occurs as a result of 2 degrees of warming
  - need more examples

Climate change is much more than global warming it is shifting of climate patterns...places that historically had abundant rain may have droughts, floods occurring in otherwise arid regions, changes in season lengths, more frequent and severe storms, etc.

(52) Ecology/Biosphere

II.

Main Idea: Terrestrial Biomes are major life zones characterized by vegetation.

Main Idea: Climate effects the type a vegetation that will grow in area.

Main Idea: Climate therefore plays an important role in the distribution of biomes around the globe

Can you give any examples of biome and its climate?

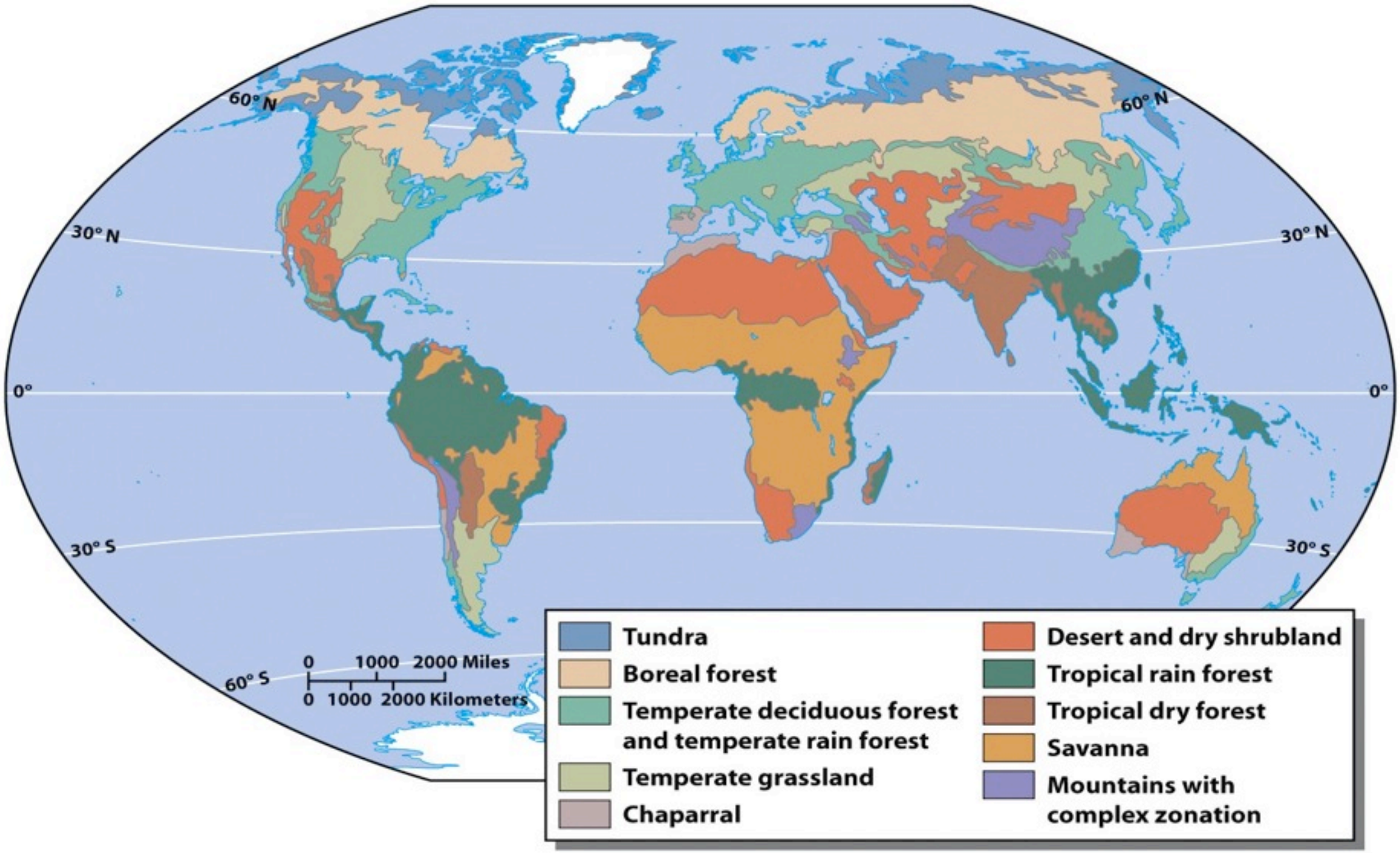
STRUCTURE AND DISTRIBUTION OF TERRESTRIAL BIOMES

A. Climate & Terrestrial Biomes

- General: Terrestrial Biomes are correlated with *latitude*
- Specifically: Terrestrial Biomes are very much dependent on *Temperature and Precipitation* (see climograph)
- More Specifically: The *pattern* of *Temperature* & *precipitation* along with the *soil* composition play the most important role

Bottom Line: Climate patterns and abiotic conditions dictate biome compositions and locations.

Terrestrial Biomes

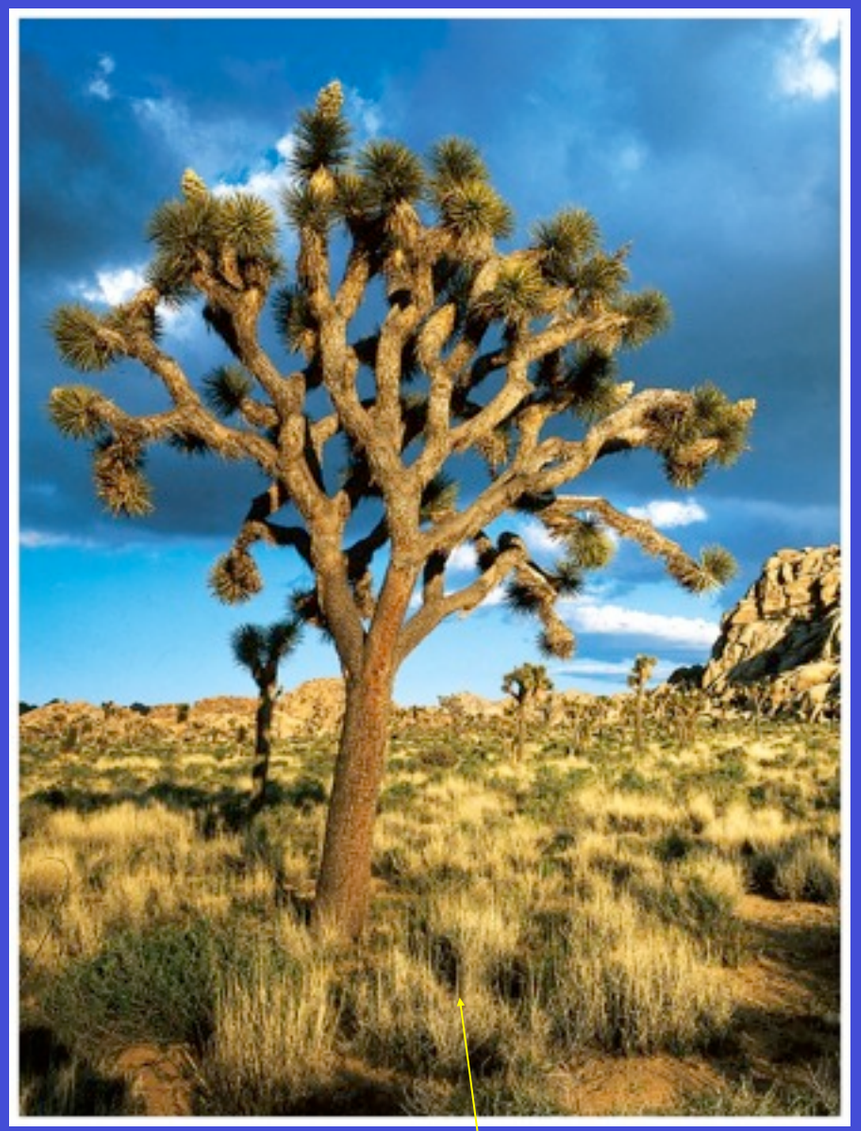


B. Terrestrial Biomes

- Have their own climates
- Have their own unique composition of species from microorganisms to mammals
- Have vertical layering, providing different habitats
- They do not have distinct divisions, instead "gray" areas called ecotones divide one biome from another

Note: The same biome located on separate continents may have 2 similar looking species that are evolutionarily do not share recent common ancestor. What is this called?

Answer: Convergent evolution

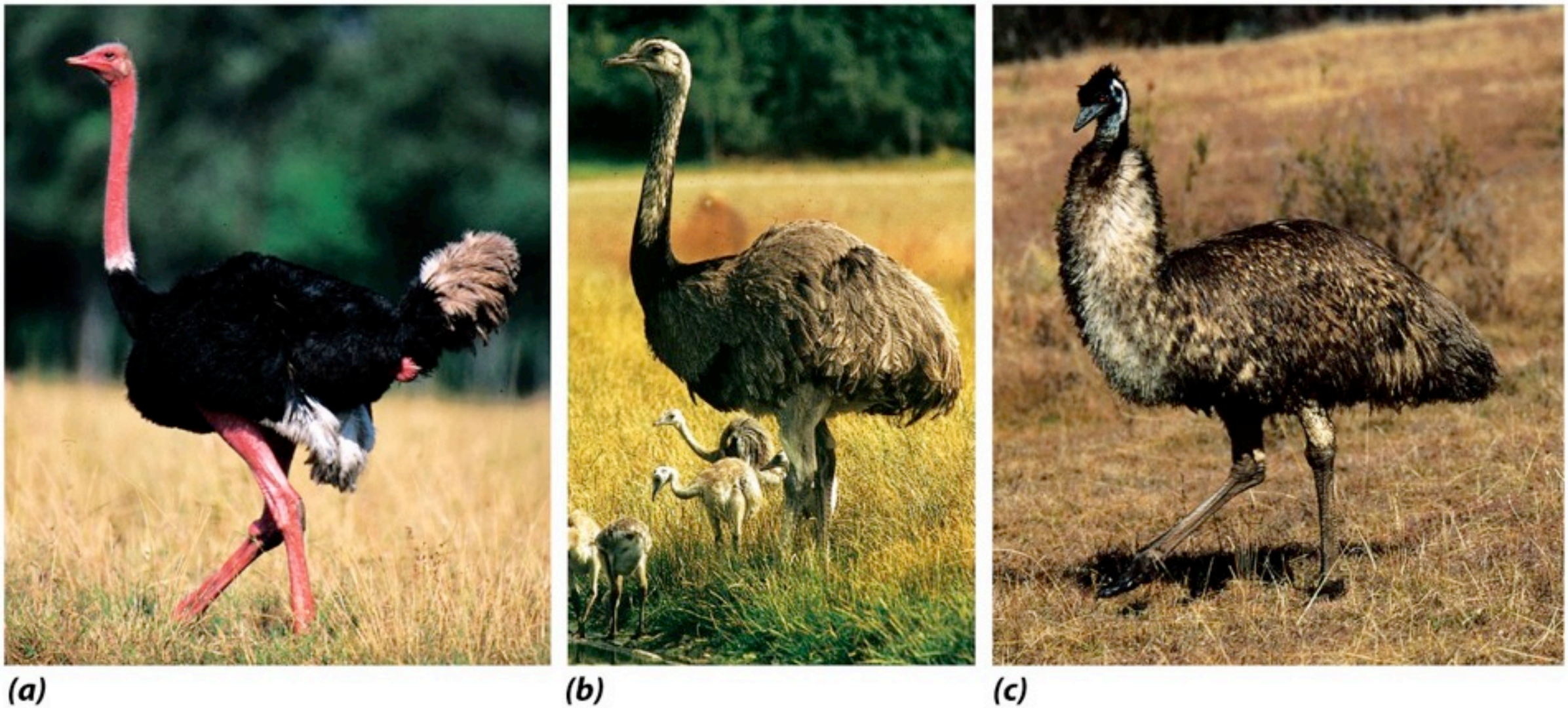


Example of Convergent evolution- given sufficient time and similar climates species similar in shape and form will tend to occur.

Joshua Tree

Saguaro from North America

Euphorbia of East Africa



Ostrich from Africa Rhea from SA Emu from Australia

Example of Divergent evolution- population is divided and each evolves separately

Convergent Evolution

Niche	Placental Mammals	Australian Marsupials
Burrower	Mole	Marsupial mole
Anteater	Anteater	Numbat (anteater)
Mouse	Mouse	Marsupial mouse
Climber	Lemur	Spotted cuscus
Glider	Flying squirrel	Flying phalanger
Cat	Bobcat	Tasmanian "tiger cat"
Wolf	Wolf	Tasmanian wolf

Flight	Hummingbird flowers
Gliders	Carrion-beetle flowers
Flightless birds on islands	Fruits underground
Giant flightless vegetarian birds	Thorns and prickles
Giant flightless carnivorous birds	Sexual dimorphism
Vultures	Heterospory
Hovering nectar feeders	Fleshy fruit
Woodpeckers	Water transport systems
The "cat" form	Wind pollination
The "horse" form	Wind dispersal of seeds
Bipedal hoppers	Nectar spurs
Mole-like forms	Hallucinogenic toxins
Burrowing lizards	Deadly skin poisons
Porcupine, armadillo forms	Antifreeze
Armored animals, spiked tails	Silk
Horned snouts	C-4 photosynthesis
Billed snouts	How to oxygenate blood
Hippo form	Bioluminescence
Dolphin form	Biomineralization
Whale form	Reef builders
Diving duck form	Magnetite for orientation
Pike form	Hydrothermal adaptations
Eel form	Lens material for eyes
Crocodile form	Ruminant forestomach
Pig form	Mycorrhizal associations
Ground sloth form	Lichens
Chameleon-like eyes	Water by fat combustion
Trichromatic color vision	Parasitic plants
Inflatable penis	Insectivorous plants
Multicellularity	Carnivory from herbivors
Eyes	Herbivory from carnivors
Hovering nectar feeders	Plankton feeding by large forms
Stiffening of extremities	Praying mantis form
Beaks	The army ant syndrome
Swim bladders	Brood parasitism
Brains	Parasitism
Ultrasonic hearing	Parthenogenesis
Clamlike shells	Male brooding of eggs
Eusociality	Male mating calls
Tree form	Camouflage
Palmlike trees	Mimicry of toxic animals
Cactus form	Whirling rods for balance
Bilateral flowers	Mineralized hairs for balance
United petals	Electrical detection of prey

C. Disturbances & Biomes

- Biomes are dynamic, stability is the exception
  - Fire, storms and human activity are constantly changing the resource availability and community structure
  - Fire is common and important natural disturbance

How are fires beneficial to ecosystems?

Answer: Fire ecology differs in each biome. In general fires will destroy build up of underbrush making large fires less likely, they are necessary for some seeds to germinate, they help recycled nutrients back into the soil, encourage succession, change soil properties, etc

Who is "Smoky the Bear"? Why is he not a well known today?

Sadly human activity is severely changing our distribution of biomes.

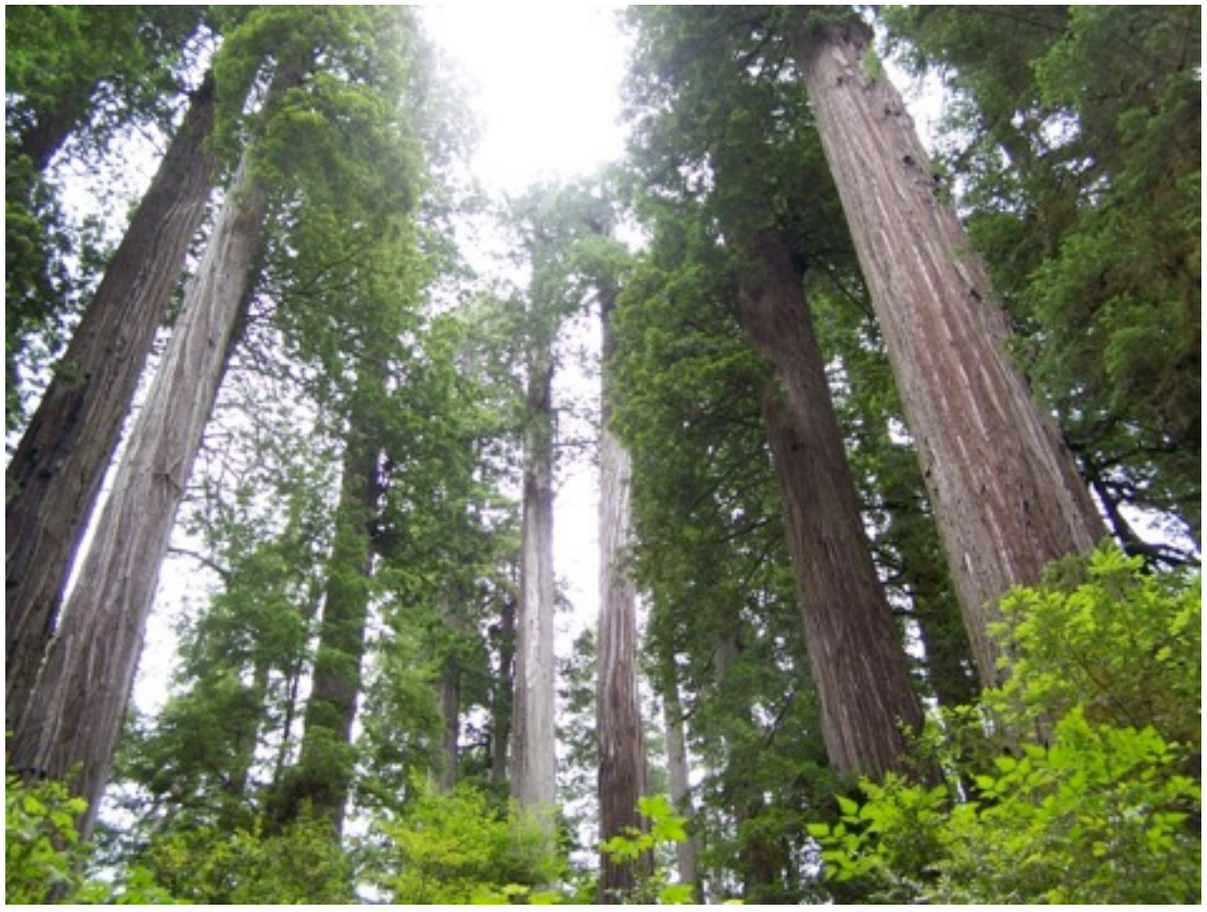
Can you name this tune? Who was the original singer?

"Ring of Fire" By: Adam Lambert Johnny Cash!

These remarkable trees below the Sequoia and Redwood are the largest (and very old) trees on the planet. They are found in area where forest fires are common and necessary for their survival. Examine the pictures below.

What adaptations might explain how these trees are fire tolerant?

Thick bark & Check out the height of the first branches

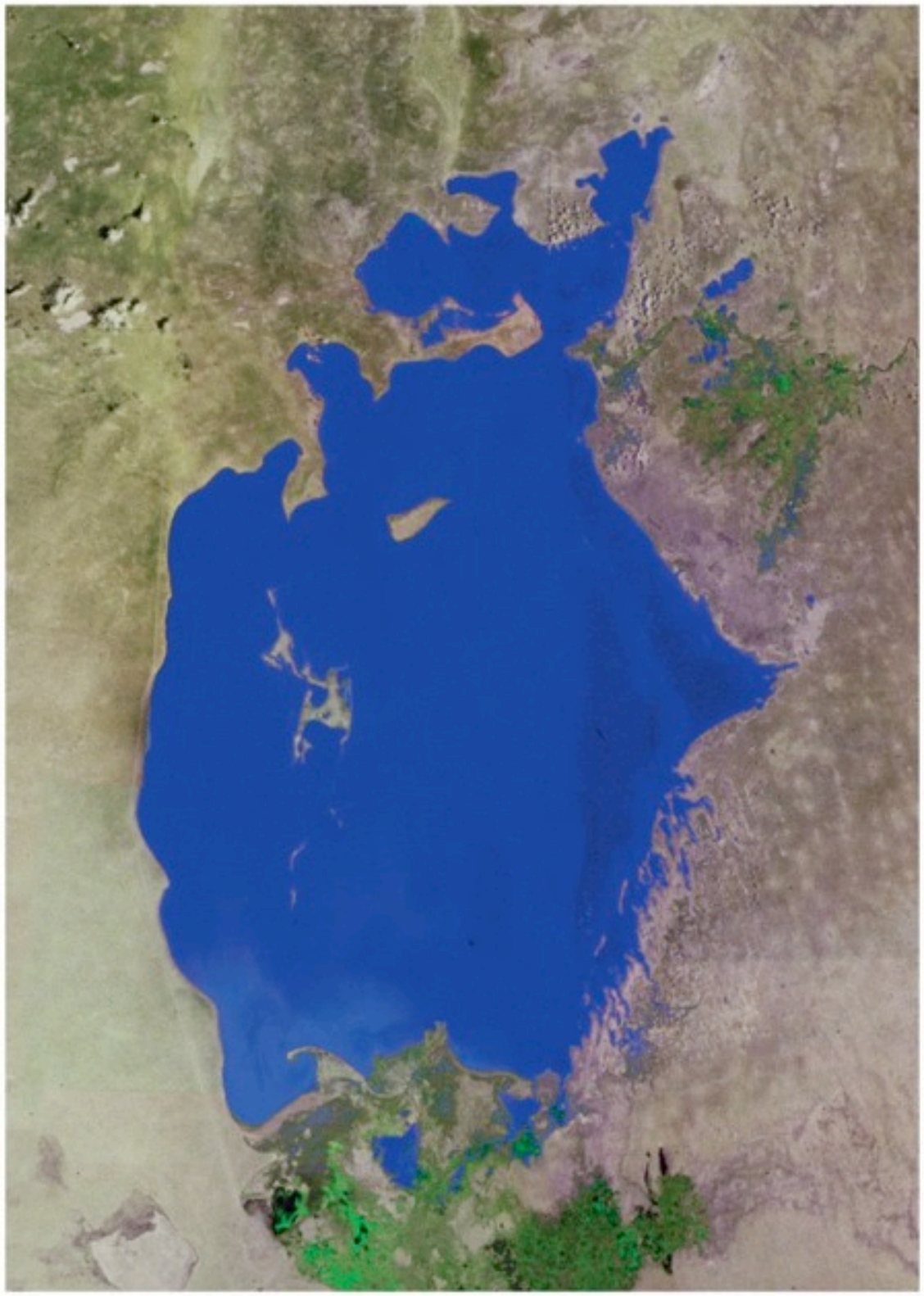


- *Sadly human activity is severely changing our distribution of biomes*
  - Boreal Deforestation (1million acres are logged annually in canada alone)
  - Desertification (land the size of Rhode Island annually turning into deserts)
  - Wetlands (221 million acres in colonial times...today only 104 million acres)
  - Coral reefs (25% of reefs worldwide are damaged and seriously threatened)
  - Tropical Deforestation (a century ago these forests covered a land area about the size of the United States...today less than 50% remain. The net loss per year is occurring a rate of a football field in size per second!)
  - Aquatic Biomes (see picture of the Aral sea on the next slide)

What are the downsides to this destruction?

loss of biodiversity, loss of potential medicines, loss of carbon sinks, loss food, loss of fertile soil, increased soil erosion, sediment pollution in rivers, changing rain patterns, floods, droughts

Aral Sea



(a) 1976

(b) 2008

(52) Ecology/Biosphere

III.

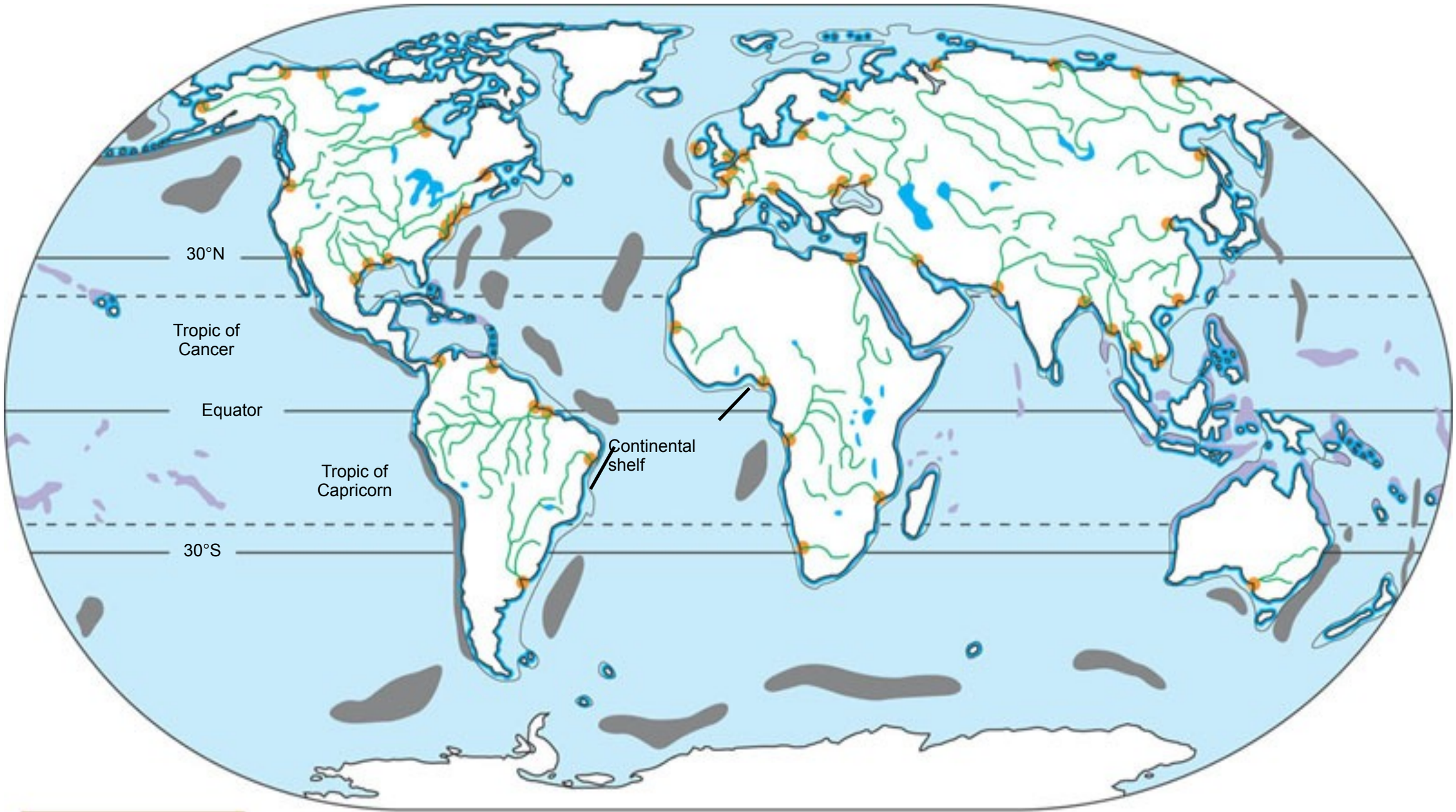
Main Idea: Aquatic biomes show little latitudinal correlation instead they are characterized by their physical factors

Can you give any examples of physical factors that are important in these biomes? What do think will be the most important one?

MARINE & FRESHWATER BIOMES

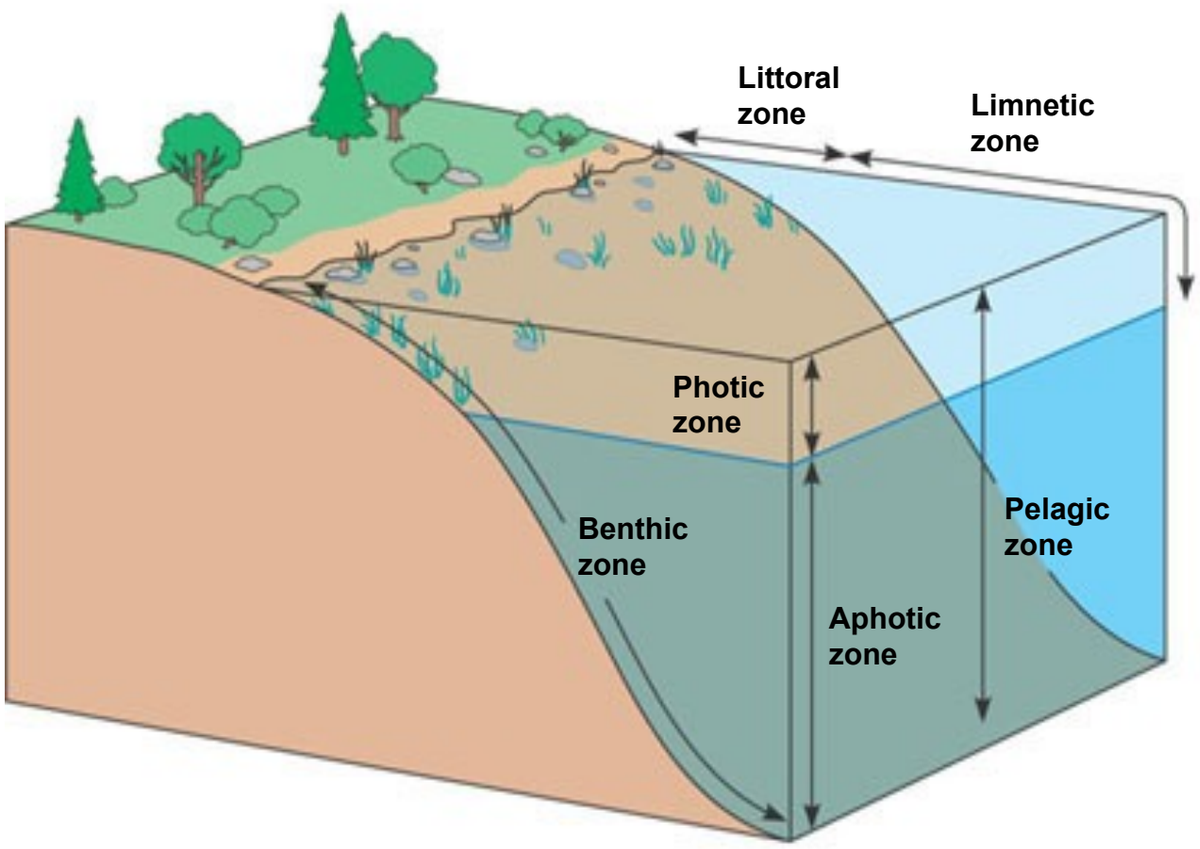
- Salt concentrations greater than 0.1%
- Water evaporated from oceans provides most of the earth's rain
- Ocean temperatures effect global climate
- Marine algae & photosynthetic bacteria provide most of the world's oxygen and consume most carbon dioxide
- Freshwater biomes are closely tied to the soils in the area
- Freshwater biomes are influenced by the pattern and speed of water in, out and through them
- Light is the most important abiotic factor; effecting the distribution and abundance of living organisms in an aquatic biome

Marine & Freshwater Biomes

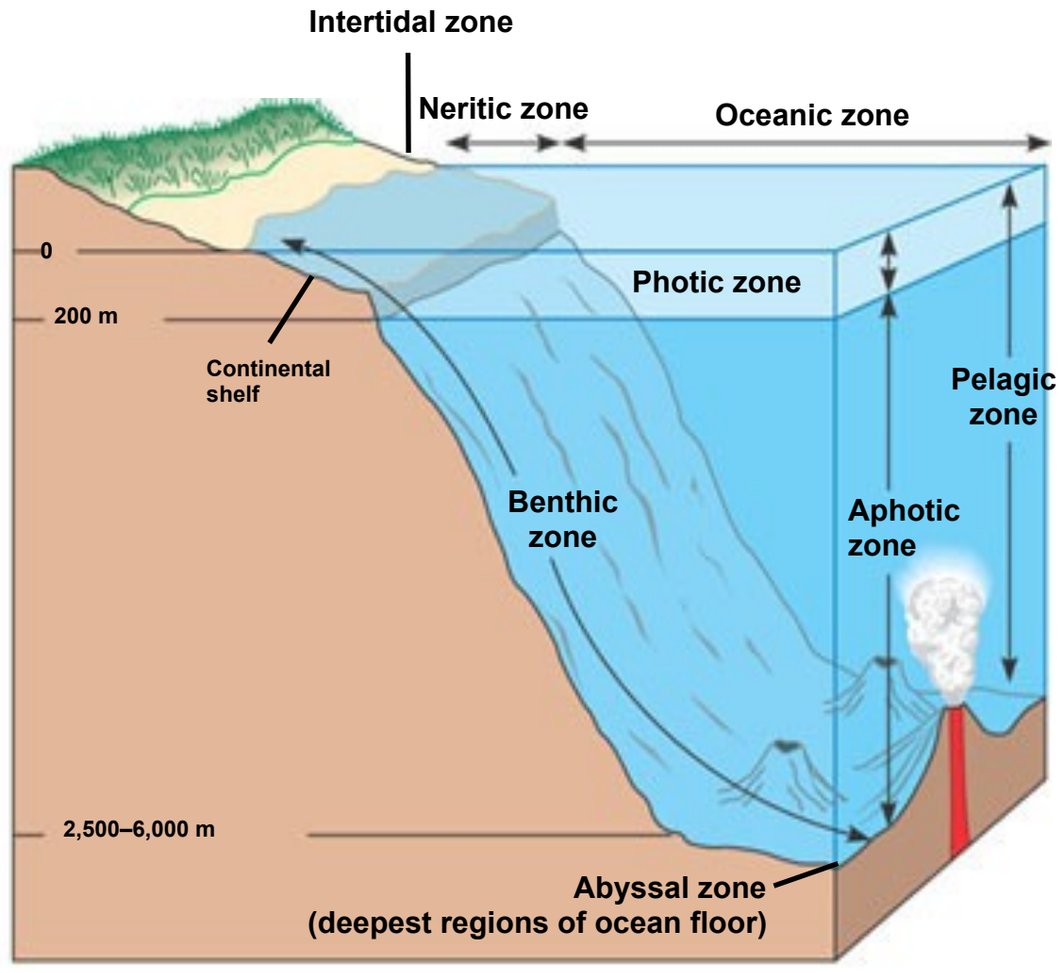


A. Aquatic Biome Zones

- Aquatic Biomes are layered by their physical and chemical properties
- They are stratified vertically and horizontally



(a) **Zonation in a lake.** The lake environment is generally classified on the basis of three physical criteria: light penetration (photic and aphotic zones), distance from shore and water depth (littoral and limnetic zones), and whether it is open water (pelagic zone) or bottom (benthic zone).



(b) **Marine zonation.** Like lakes, the marine environment is generally classified on the basis of light penetration (photic and aphotic zones), distance from shore and water depth (intertidal, neritic, and oceanic zones), and whether it is open water (pelagic zone) or bottom (benthic and abyssal zones).

A. Aquatic Biome Zones

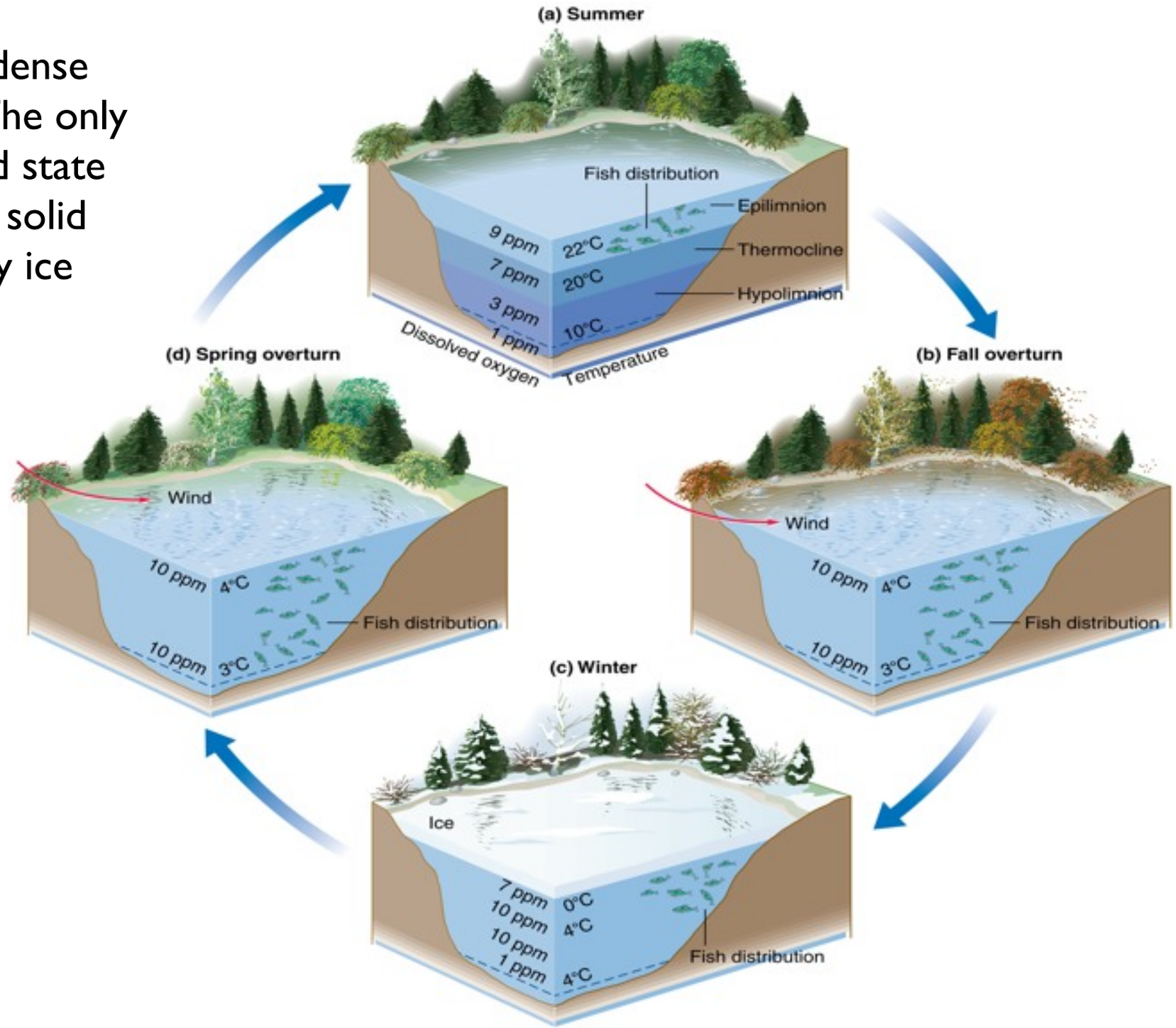
- Key Aquatic Biome Zones
- Pelagic = open water
  - Photic = light penetration
    - littoral (freshwater) & neritic (marine) = shallow
    - limnetic (freshwater) & oceanic (marine) = deep
  - Aphotic = no/little light penetration
    - Abyssal = deep ocean between 2000-6000m below
  - Benthic = the bottom; shallow or deep (like the soil!)

Aquatic life is distributed according to the *water depth, light penetration, distance from the shore,* and whether they are found in *open water* or *at the bottom.*

Freshwater (Lake) Turnover

- Seasonal mixing of oxygen and nutrients in lake

Note: Water is most dense of 4 degrees Celcius. The only substance whose liquid state is more dense than its solid state. This explains why ice floats.



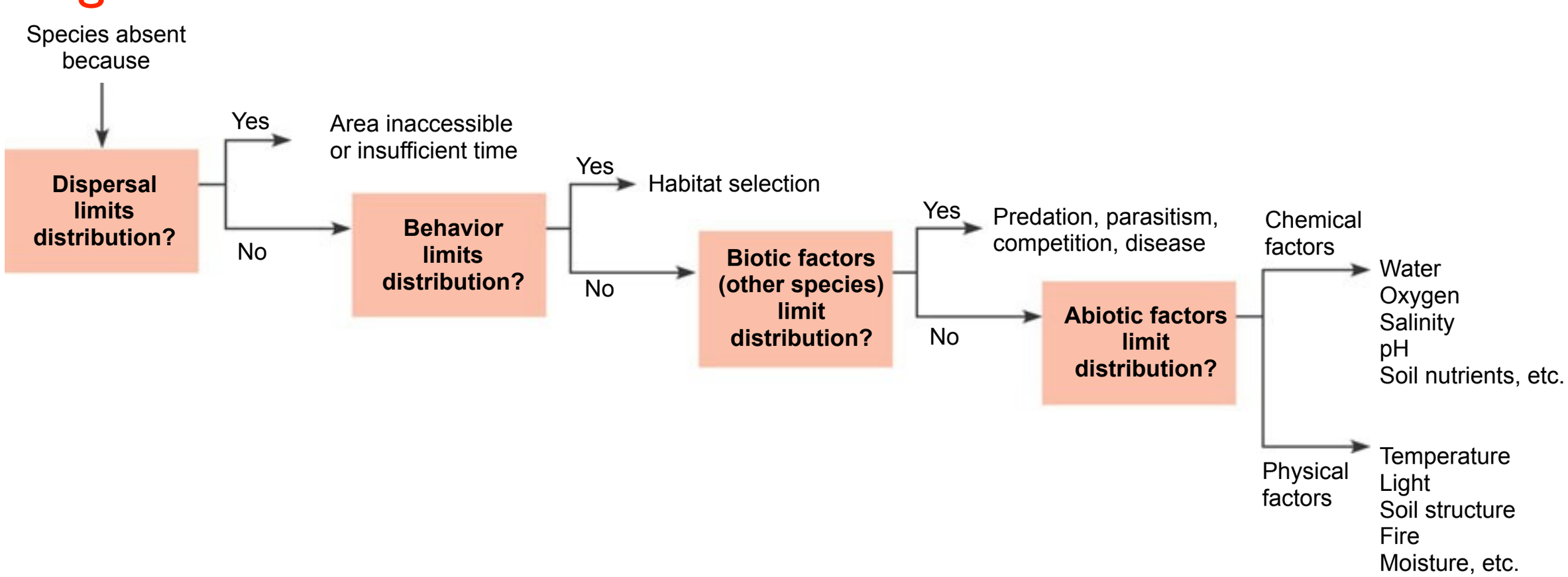
Does density contribute to these currents?

Are nutrients being cycled? Temperature?

(52) Ecology/Biosphere

IV.

Main Idea: Interactions between organisms (biotic factors) along with the physical environment (abiotic factors) and are responsible for the global and regional distribution (biogeography) of organisms.



DISTRIBUTION OF SPECIES

A. Dispersal and Distribution

...movement of individuals or gametes away from their area of origin or high population density

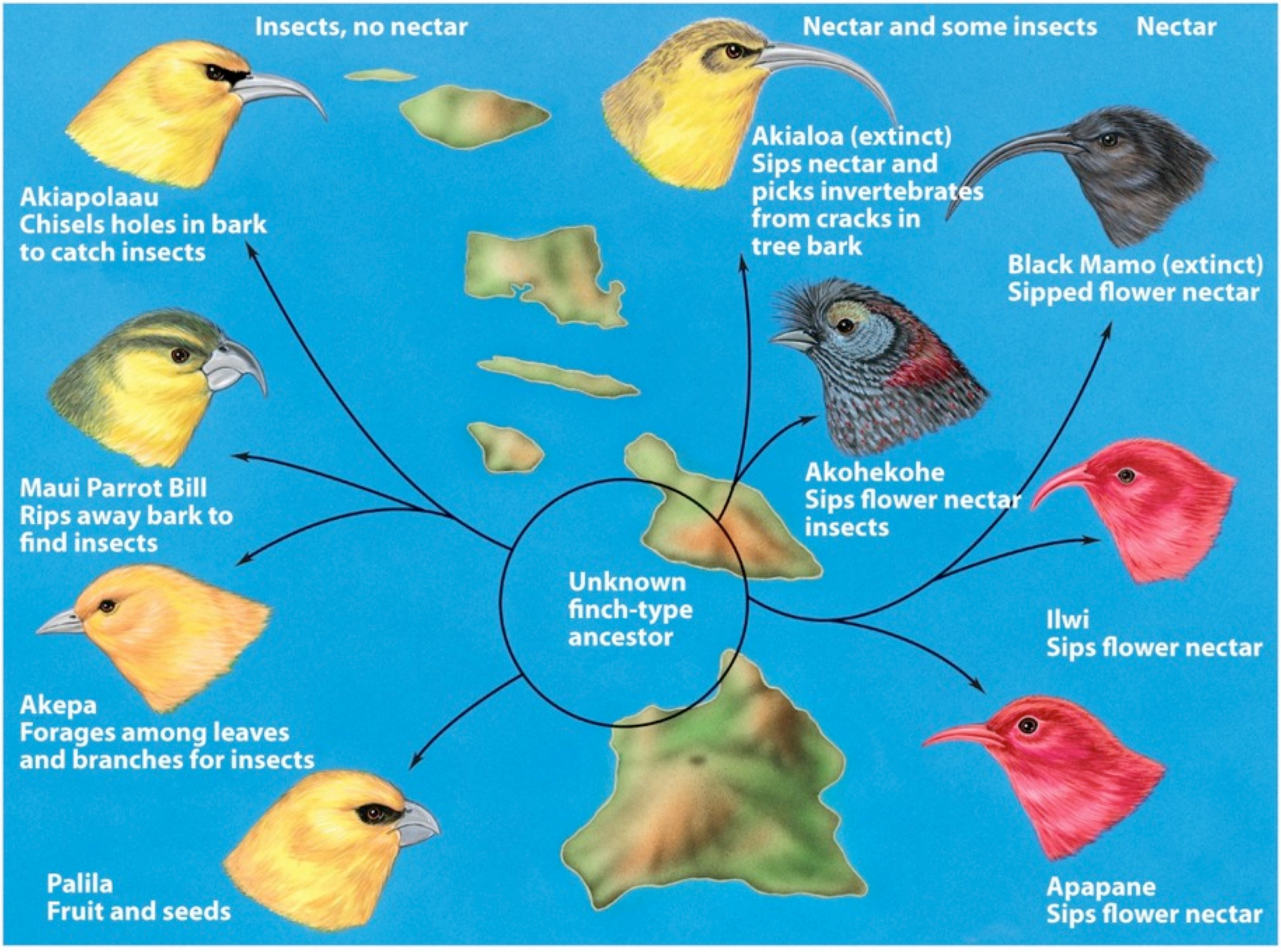
1. Natural Range Expansion

- In some cases long distance dispersal can lead to *adaptive radiation*; the rapid evolution of an ancestral species into new species that fill new niches

2. Species Transplants

- intentional or accidental transplant of species to areas where it was previously absent
- if successful then we conclude that the species potential range is larger than its actual range
  - *most transplants disrupt the ecosystem they move into*

Adaptive Radiation



B. Behavior and Habitat

...when individuals seem to avoid suitable habitats their distribution may be limited by their behavior

C. Biotic Factors

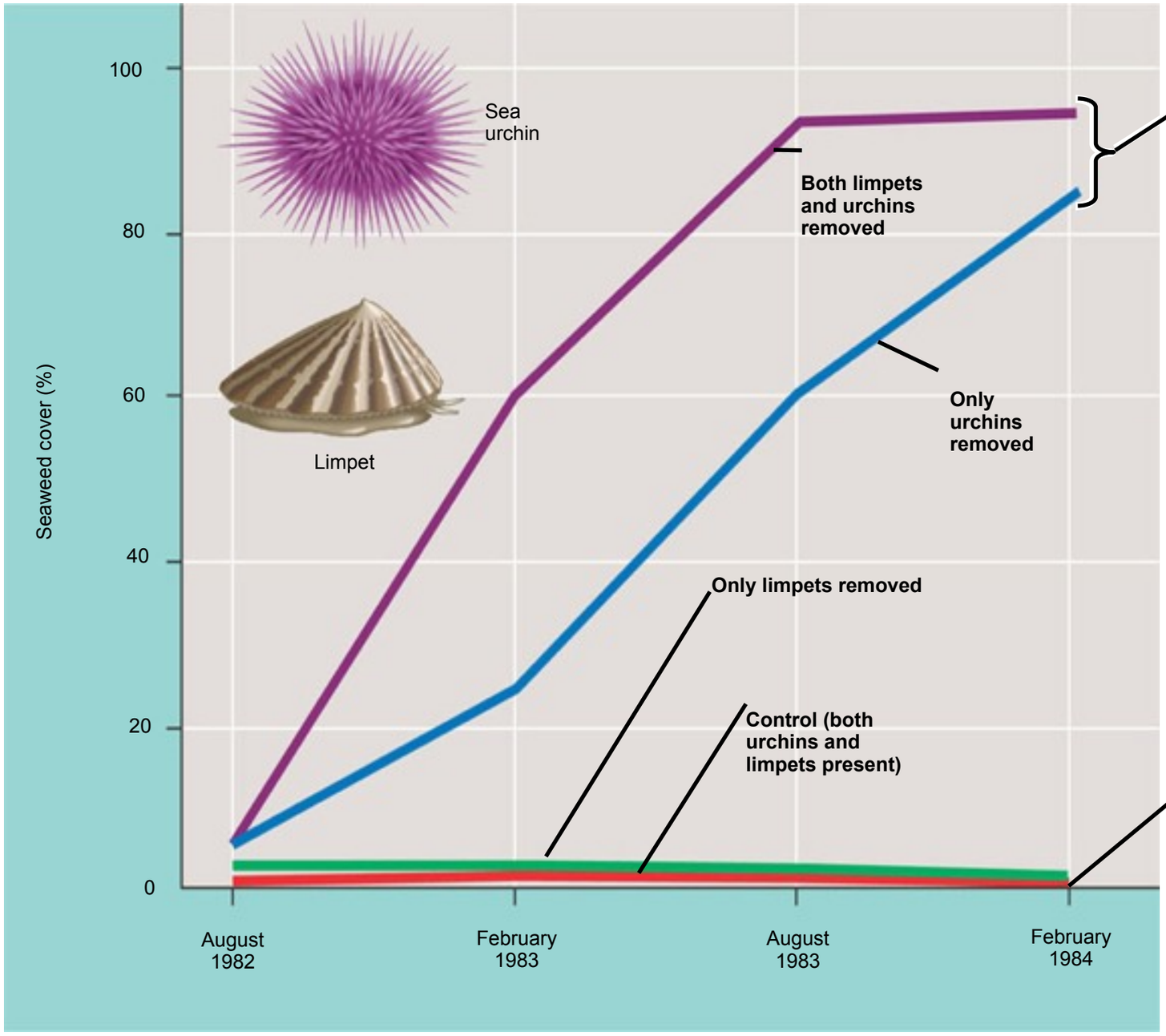
- *Predation* and *herbivory* are the most common biotic factors effecting the distribution of species
  - see next slide for a classic example
- After predation and herbivory... *food resources, parasites, pathogens, competition and absence of pollinators* are often found effecting the distribution of species

EXPERIMENT

W. J. Flecher tested the effects of two algae-eating animals, sea urchins and limpets, on seaweed abundance near Sydney, Australia. In areas adjacent to a control site, either the urchins, the limpets, or both were removed.

RESULTS

Fletcher observed a large difference in seaweed growth between areas with and without sea urchins.



CONCLUSION

Removing both limpets and urchins resulted in the greatest increase of seaweed cover, indicating that both species have some influence on seaweed distribution. But since removing only urchins greatly increased seaweed growth while removing only limpets had little effect, Fletcher concluded that sea urchins have a much greater effect than limpets in limiting seaweed distribution.

D. Abiotic Factors

- temperature, water, oxygen, salinity, light, soil
- If physical conditions of an area are not conducive for a species, then they will not be found there
- abiotic factors can vary over space and time (short term and long term fluctuations)
- organisms can sometimes temporarily avoid stressful conditions through behavioral adaptations
  - ex. dormancy, hibernation, migration

1. Temperature

- very important factor because cells can rupture when temp drops below 0 degrees C and enzymes can denature at temps above 45 C
- mammals and birds have to use energy to maintain acceptable internal temps
    - (thermoregulation...review for AP exam)
- some organisms have remarkable adaptations for living outside the normal ranges of temps
    - (thermophilic bacteria...review for AP exam)

2. Water

- perhaps the most important in terrestrial habitats
- many organisms particularly terrestrial organisms face a constant threat of desiccation (drying out)
  - their challenge lies in obtaining and/or conserving water
  - desert organisms have remarkable adaptations for this
    - (water conservation adaptations...review for AP exam)
      - production of concentrated urine
      - C4 and CAM photosynthesis
      - xerophyte adapatations
      - regulation of transpiration

3. Water and Oxygen

- oxygen diffuses slowly in water
- the oxygen concentration in water and soils can vary a great deal
  - rapidly moving water tends to have more oxygen
  - cold water can hold more oxygen than warm water
  - as detritus increases oxygen concentration decreases
- oxygen is needed for cellular respiration and other fundamental processes
  - some trees have aerial roots, an adaptation that helps the trees live in submerged soils...review for AP exam

4. Salinity

- salts can pose a great challenge for organisms since they can effect water balance in organisms through osmosis
  - high salinity habitats generally have few species
- the regulation of salts (and to some extent water) is important for most organisms
  - (osmoregulation...review for the AP exam)

5. Sunlight

5. Sunlight

- The ultimate source of energy for most ecosystems and life on earth!
- Sunlight can effect distribution of life of on land but sunlight very much determines the distribution of aquatic life
- Too much light = high temperatures and increase in harmful UV radiation
- Too little light = no photosynthesis
    - Every meter of water depth absorbs 45% of red light and 2% of blue light
        - This explains why the ocean is blue
        - More importantly it explains why most autotrophs (the foundation of most food webs) are distributed at the surface of the water

6. Soil and Rocks

- The pH, Minerals and physical composition of the soil limits plants distribution
- Once again if plants (the foundation are food webs) are limited then so will the animals that feed on them
- Soil pH can directly limit plant growth or indirectly limit plant growth by altering solubility nutrients and toxins in the soil
  - (Review soil chemistry and cation exchange)
- The types of rocks in rivers can alter water chemistry
- The bottom of the lake or ocean can effect the type of plants that can take root

Stop and Think

Which latitude(s) would have the most pronounced seasons?

Would you expect adapting to life in these latitudes to be more or less challenging?

Can you think of any general or specific adaptations found in these parts of the world?

Mammals generally get larger as move towards the poles can you guess why?

Can name any animals that live in high elevations? Can guess what adaptations they might have that allow them to be successful in this niche?

Stop and Think

How is climate change today different from past geological episodes?

If you were drifting in life boat and needed to catch a fish for food. Would it be wiser to drop you only bait deep into the ocean or drag it on the surface? Why?