



Chapter 4

Global Climates and Biomes

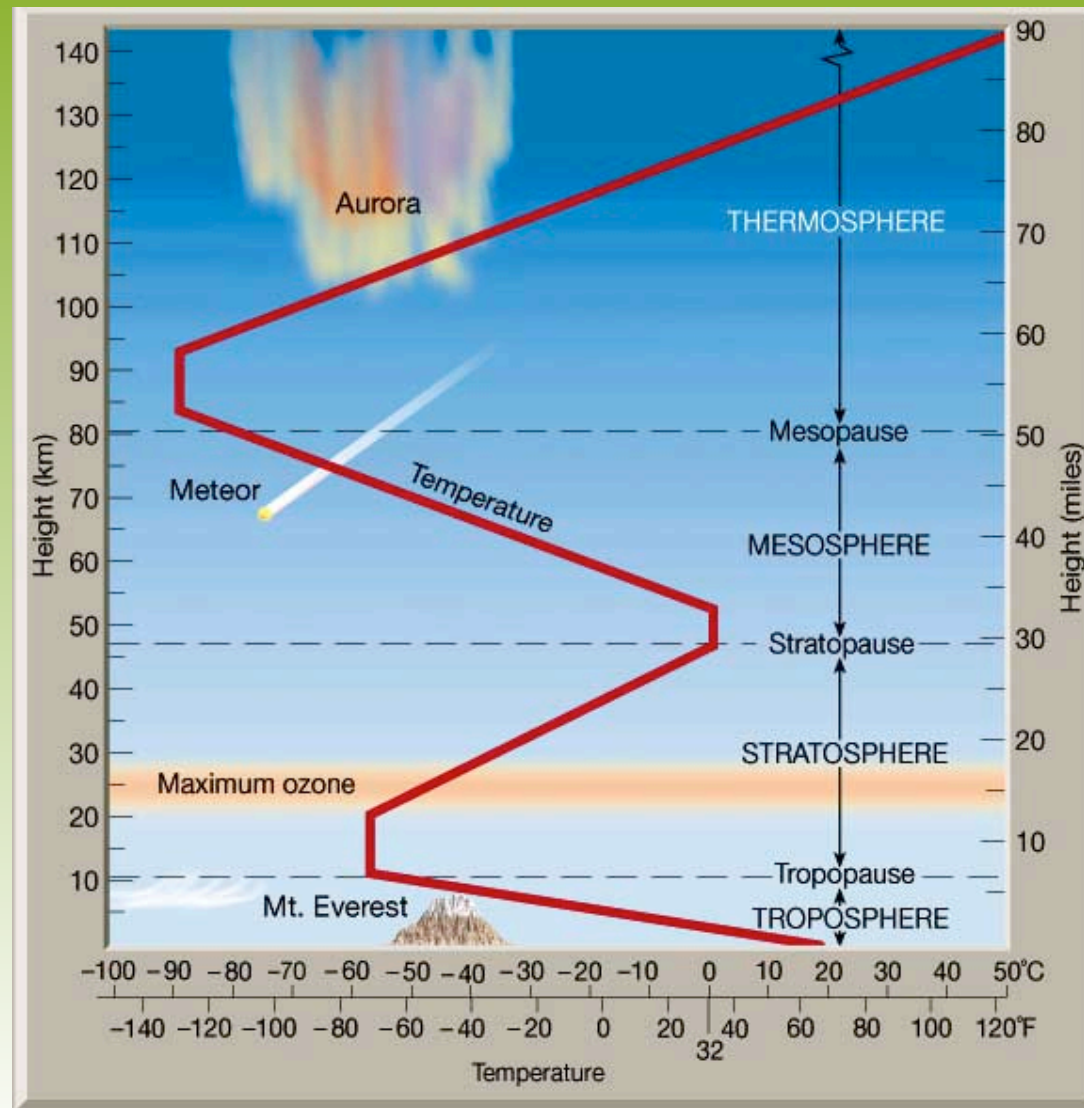
Floods, Drought, Biomes



Global Processes Determine Weather and Climate

- **Weather-** the short term conditions of the atmosphere in a local area. These include temperature, humidity, clouds, precipitation, wind speed and atmospheric pressure.
- **Climate-** The average weather that occurs in a given region over a long period- typically several decades.

Earth's Atmosphere



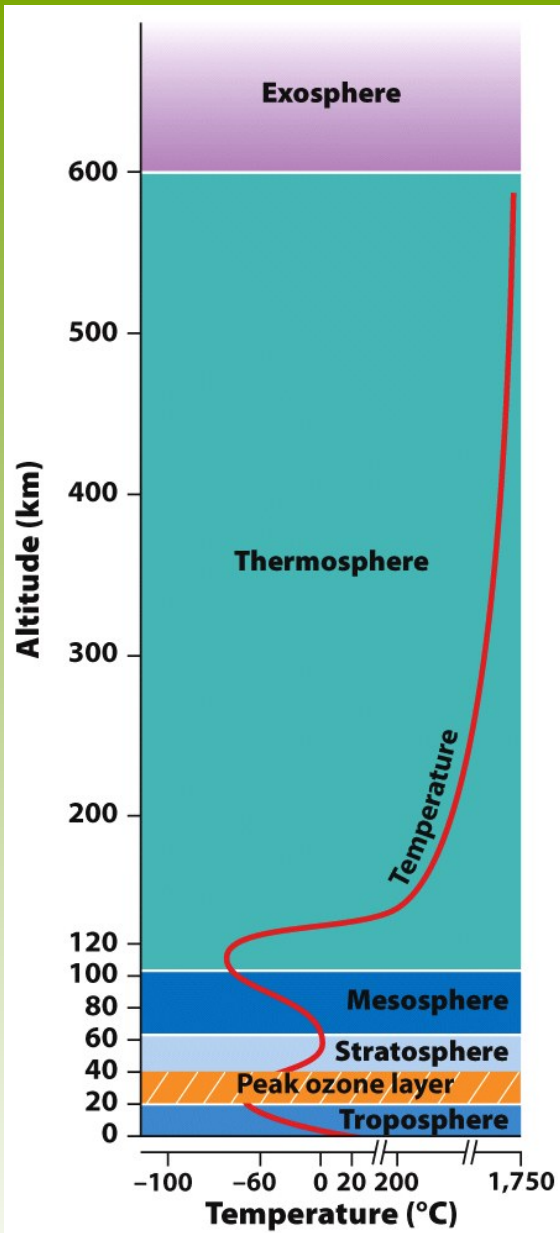
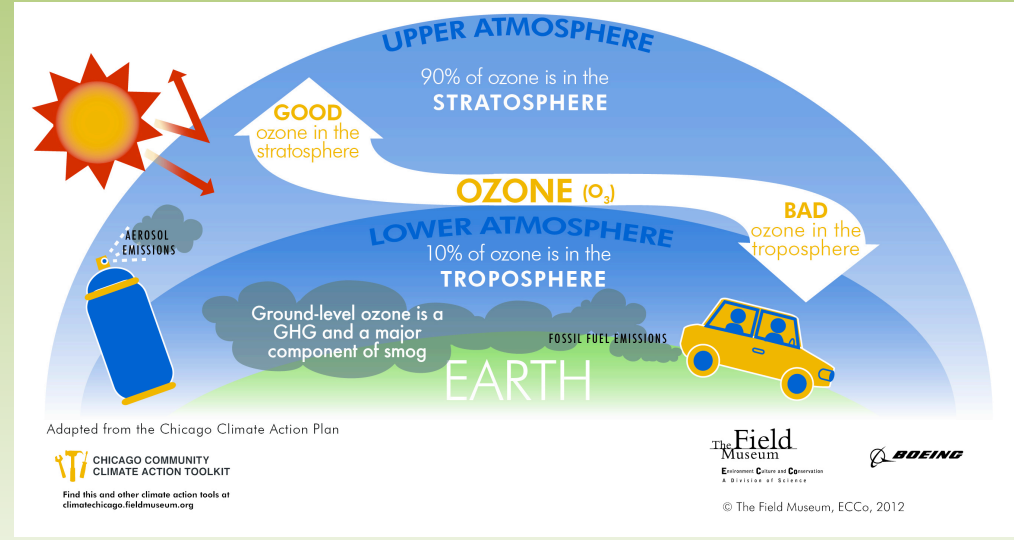


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Adapted from the Chicago Climate Action Plan

CHICAGO COMMUNITY CLIMATE ACTION TOOLKIT
 Find tips and other climate action tools at climatechicago.fieldmuseum.org

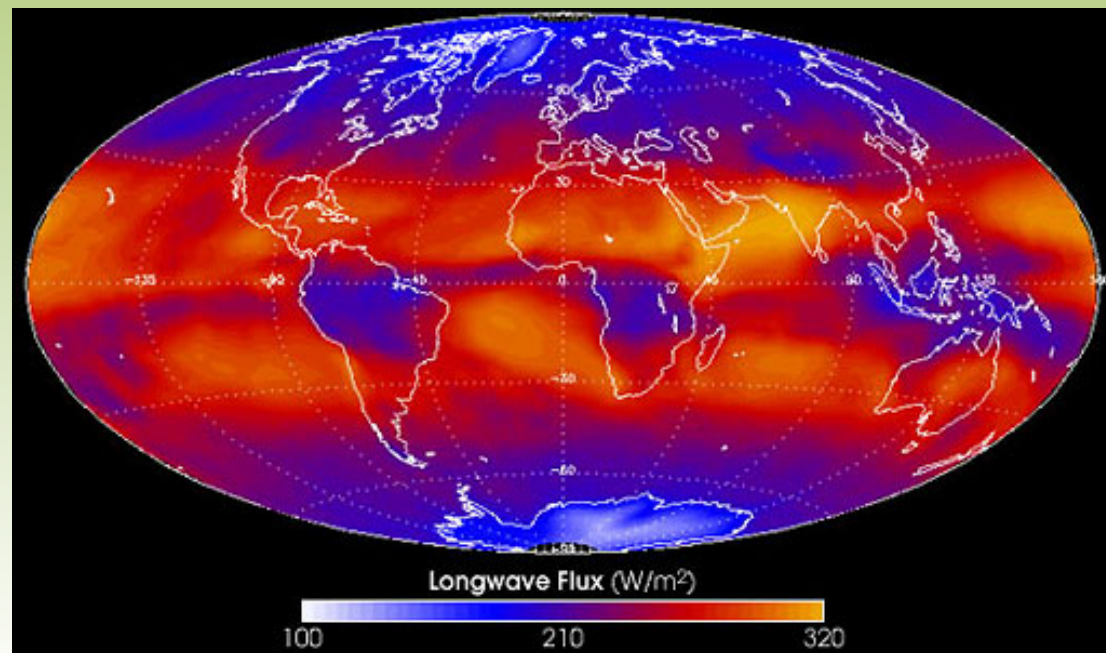
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 A Division of Science



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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.



Uneven Heating of the Planet

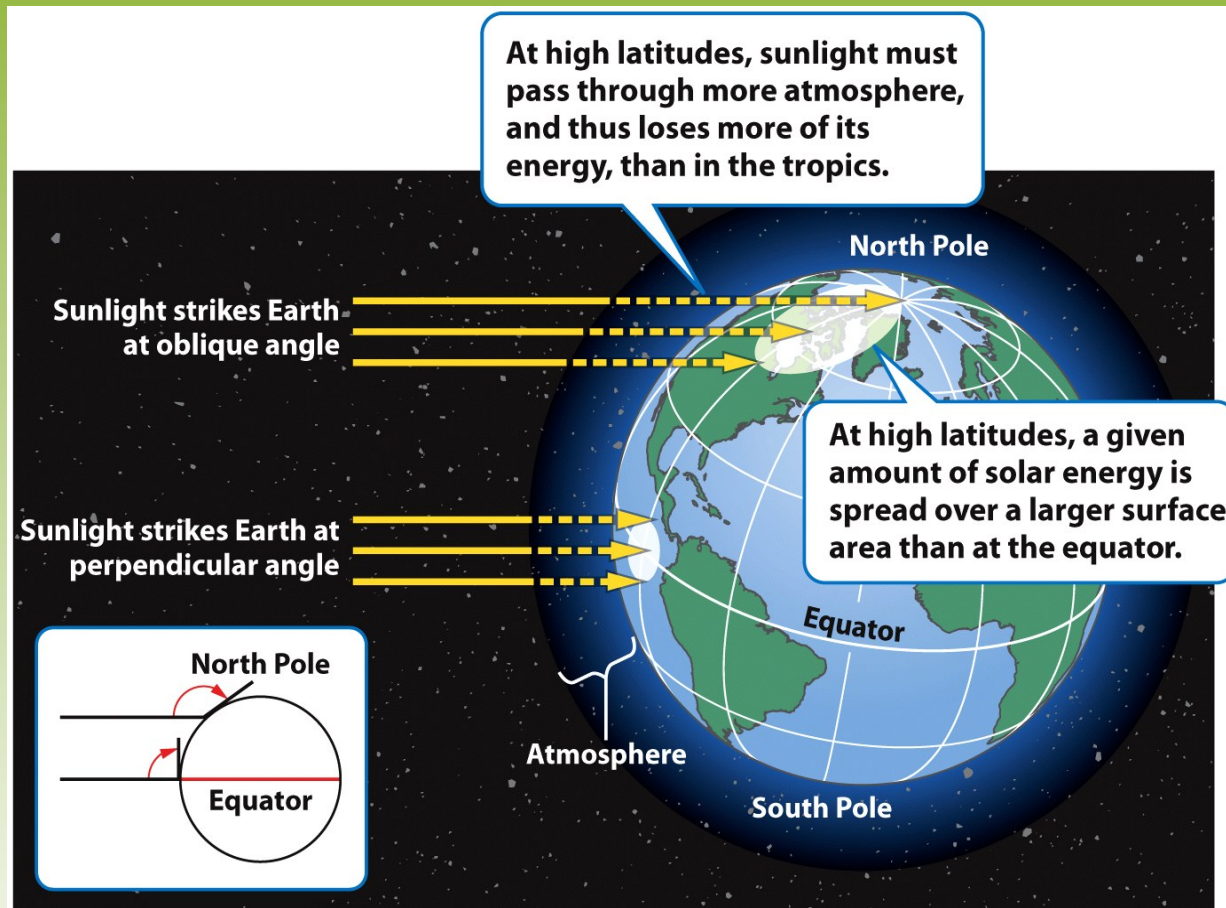
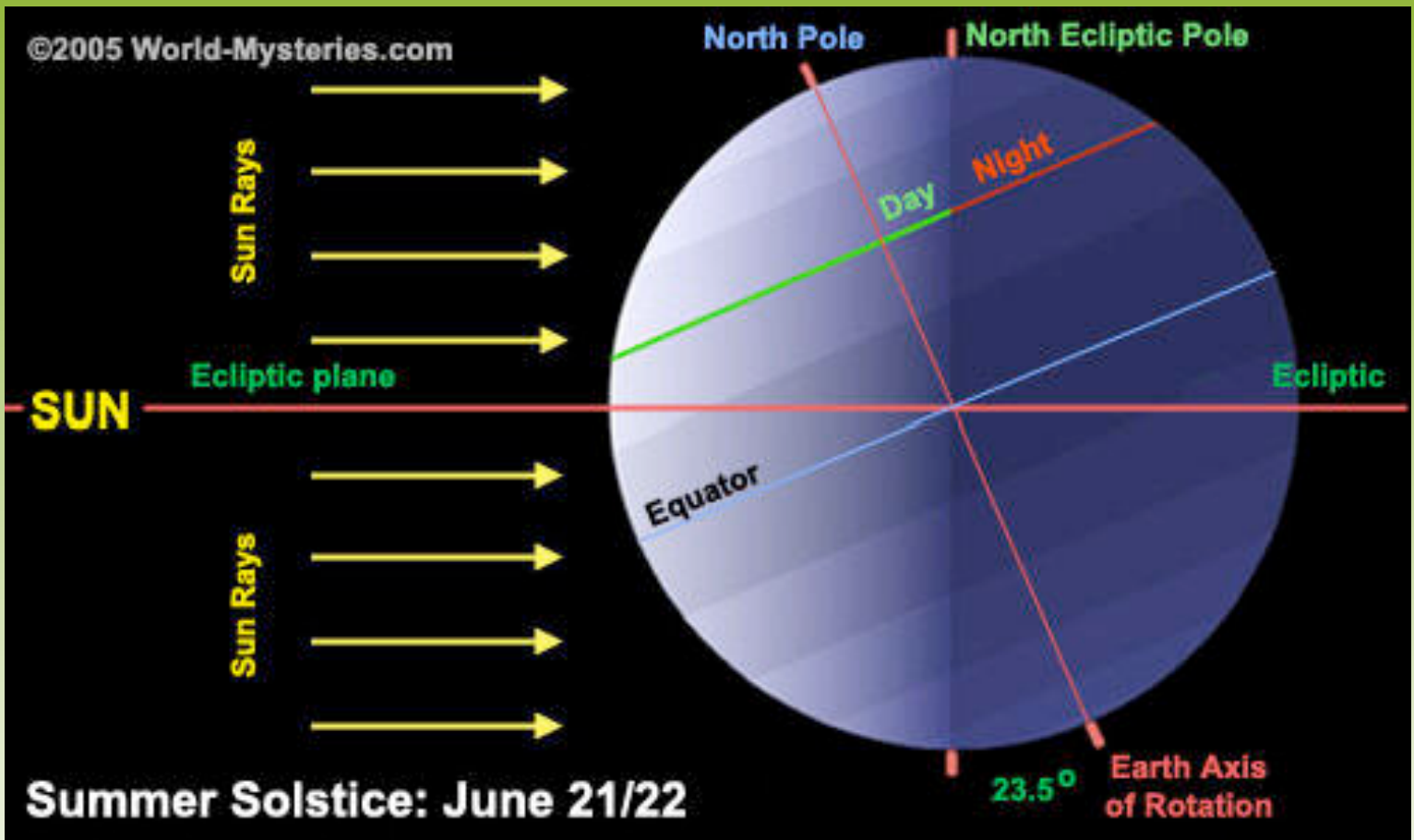


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Unequal Heating of Earth

- This unequal heating is because:
 - The variation in angle at which the Sun's rays strike
 - The amount of surface area over which the Sun's rays are distributed
 - Some areas of Earth reflect more solar energy than others. (Albedo)

POSITIVE FEEDBACK MECHANISM

a chain reaction where small change creates an effect that causes an even bigger change

THE ALBEDO EFFECT

ability of a surface to reflect light

REFLECTED
40%

SOIL ALBEDO

Exposed land is darker coloured and absorbs more energy. As the ice melts, more land is exposed. As a result it absorbs more heat, melting more ice.

REFLECTED
90%

SNOW ALBEDO

A small amount of snow melt exposes darker ground which absorbs more radiation, leading to more snow melt.

REFLECTED
10%

OCEAN ALBEDO

The albedo of ocean water is much lower, so it absorbs the rays, trapping the heat. The more sea water is exposed, and the less sunlight is reflected, causing temperatures to rise, and causing more ice to melt.

**60%
ABSORBED**

**10%
ABSORBED**

**90%
ABSORBED**

square miles

AREA
836K

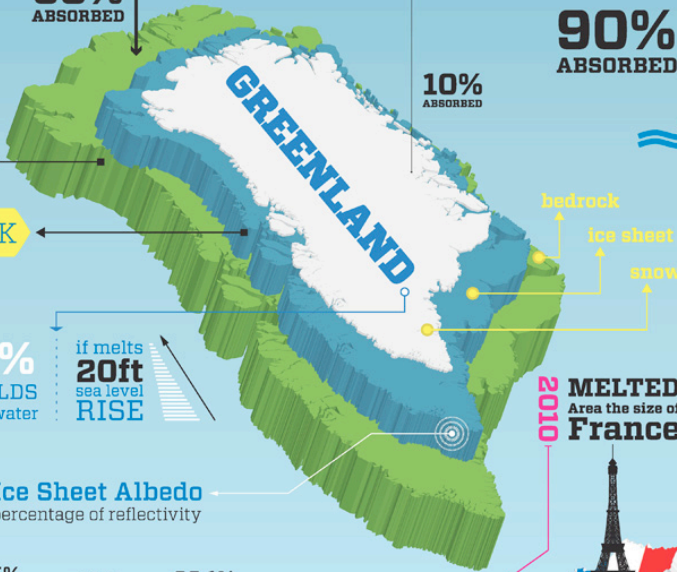
square miles

656K



**10%
WORLD'S
fresh water**

if melts
**20ft
sea level
RISE**

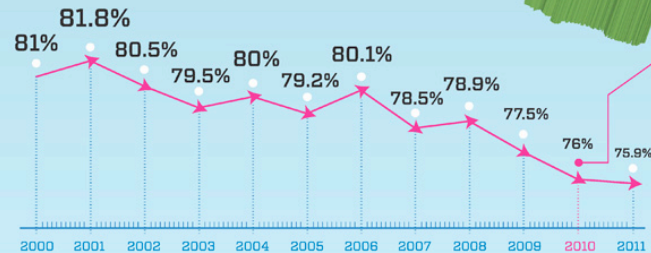


**MELTED
Area the size of
France**



Greenland Ice Sheet Albedo

percentage of reflectivity



**INCREASING
MELTING RATE
6600
SQUARE MILES
PER YEAR**

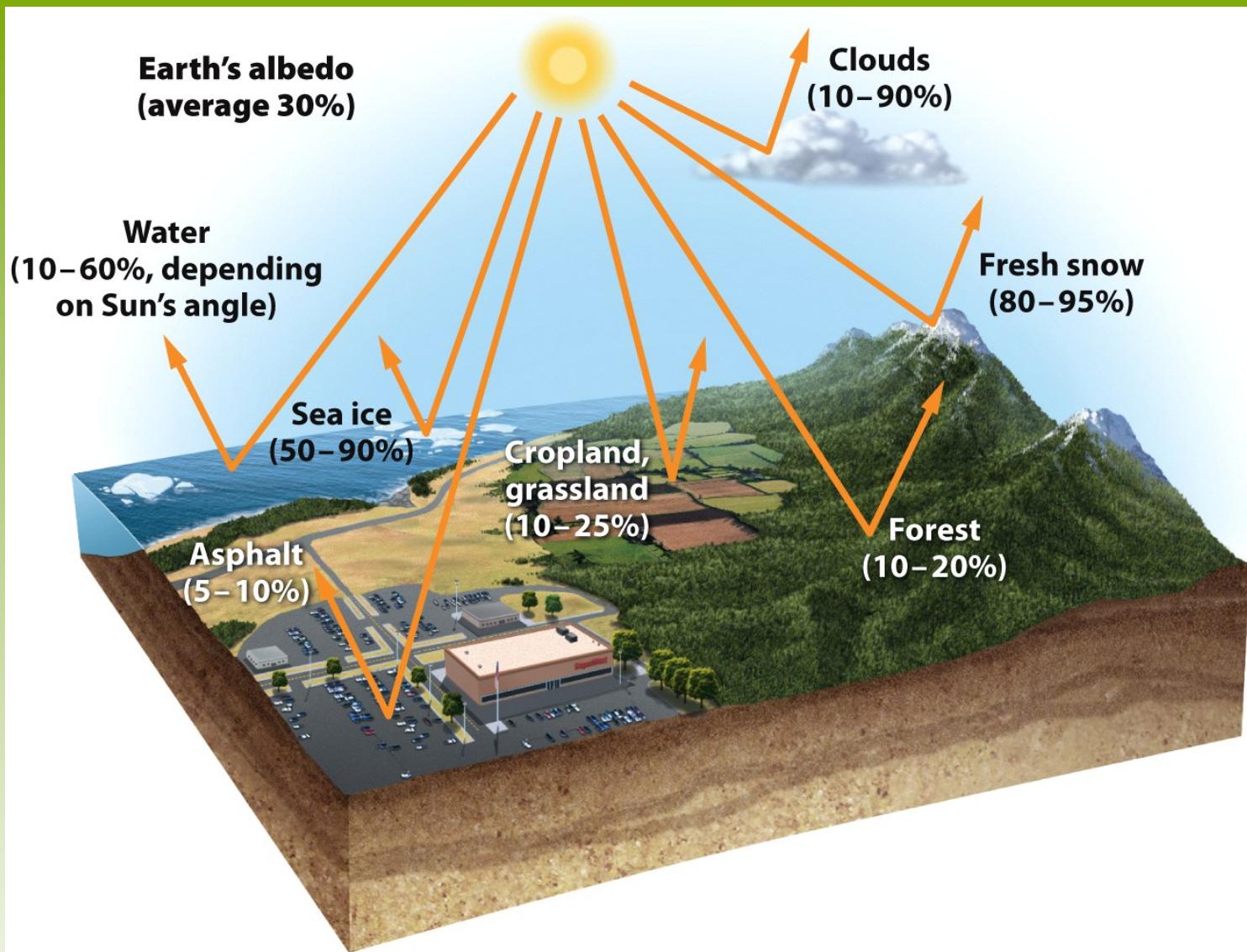


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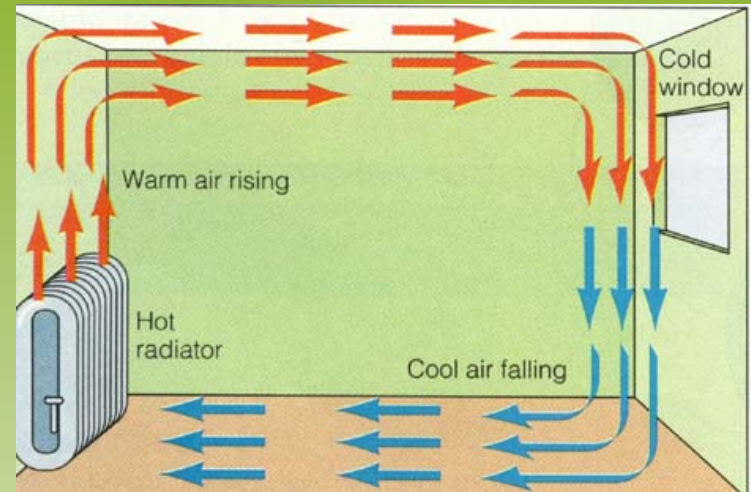
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Atmospheric Convection Currents

Vertical movements...4 properties:

Density- warm air rises, cold air sinks



Water vapor capacity-
(Saturation point or Dewpoint)

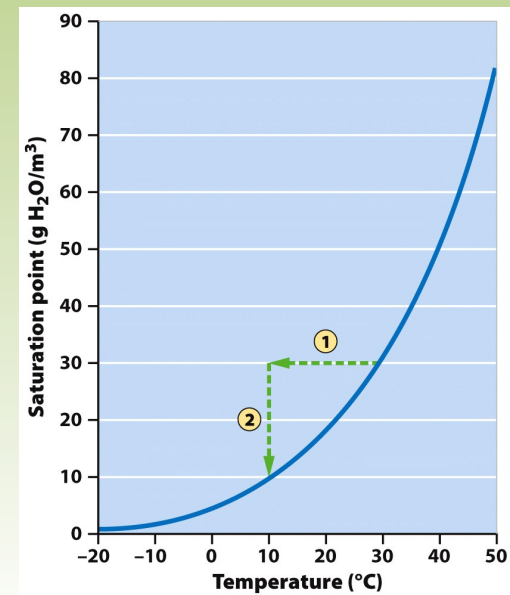


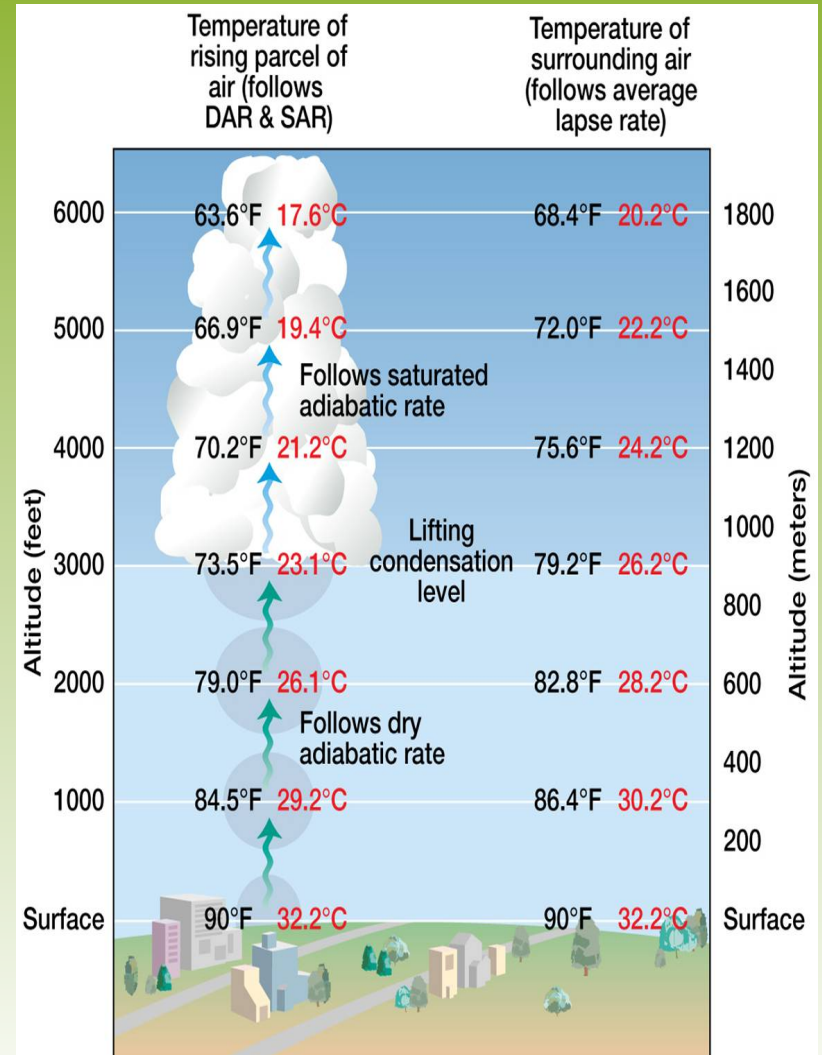
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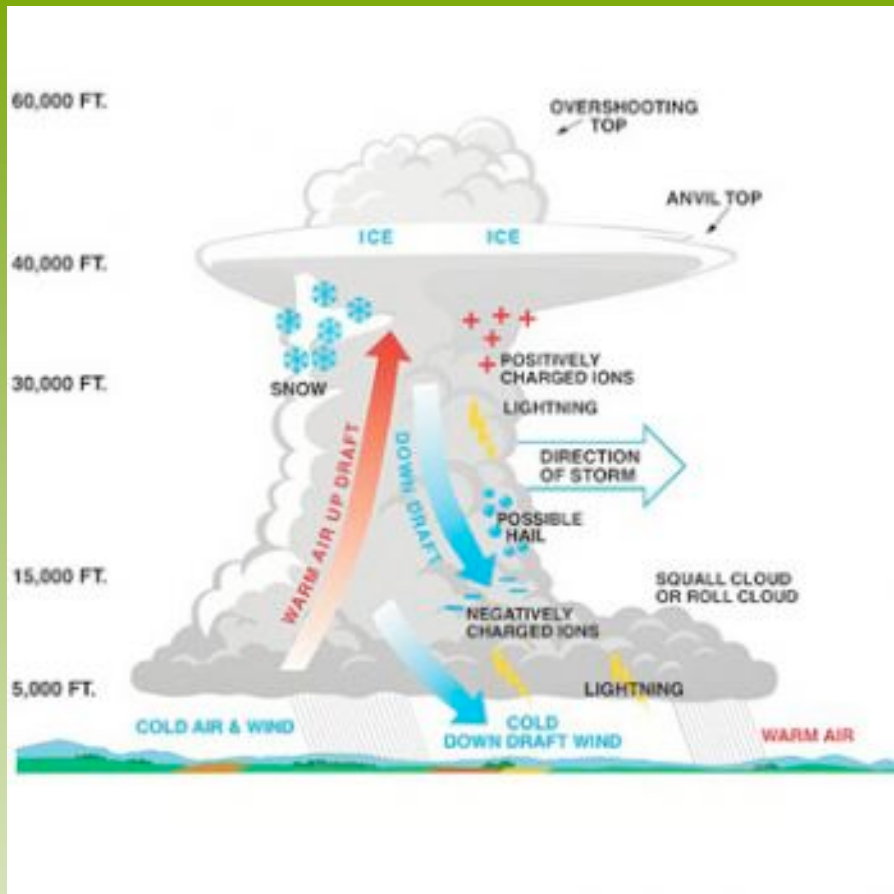
Convection Currents

Pressure Changes:
Adiabatic cooling – rising air expands and cools.

Adiabatic heating – sinking air compresses and heats.

Latent Heat released during condensation drives updrafts.





Formation of Convection Currents

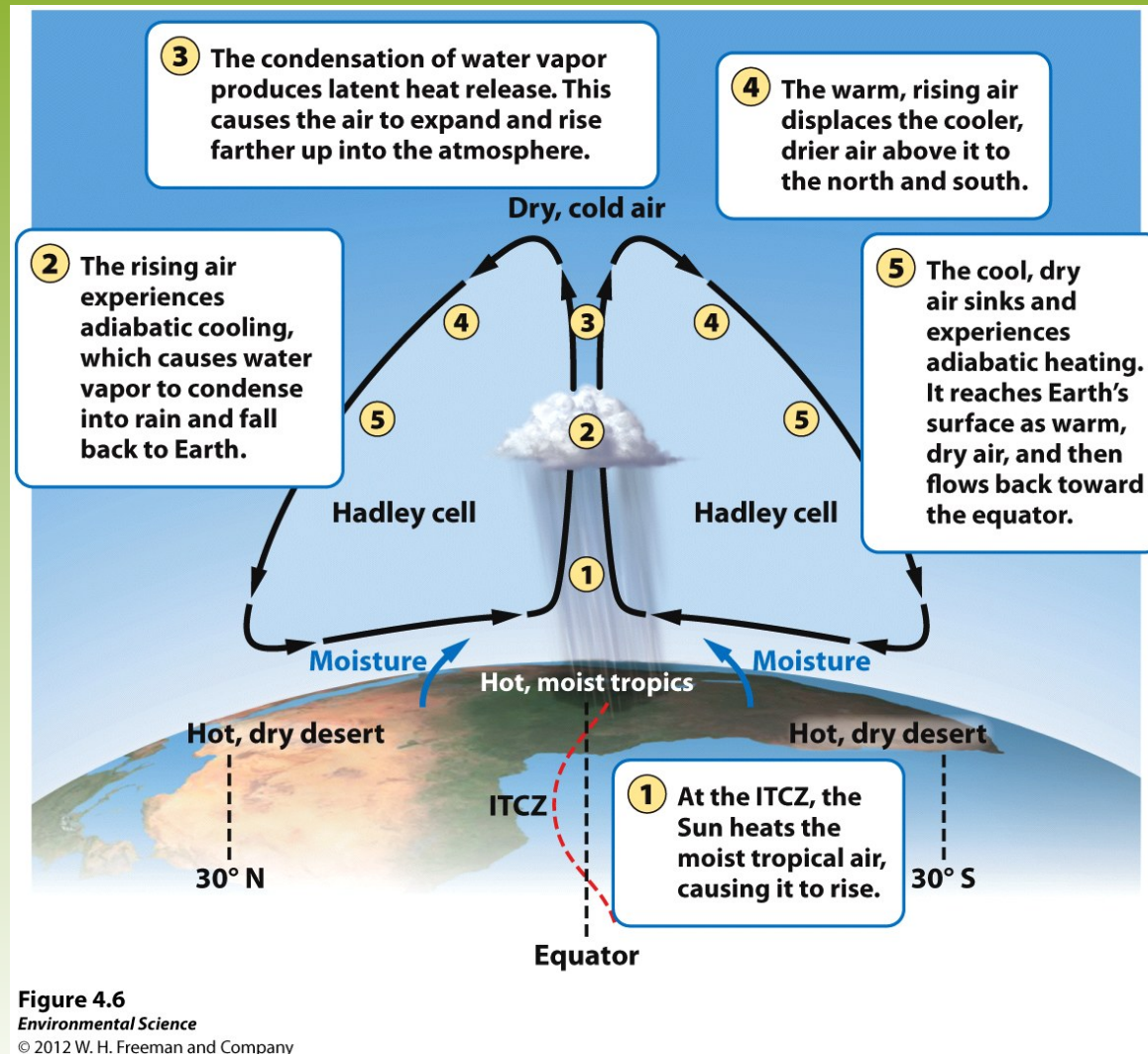


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Global Wind Belts... the atmospheric heat distribution system.

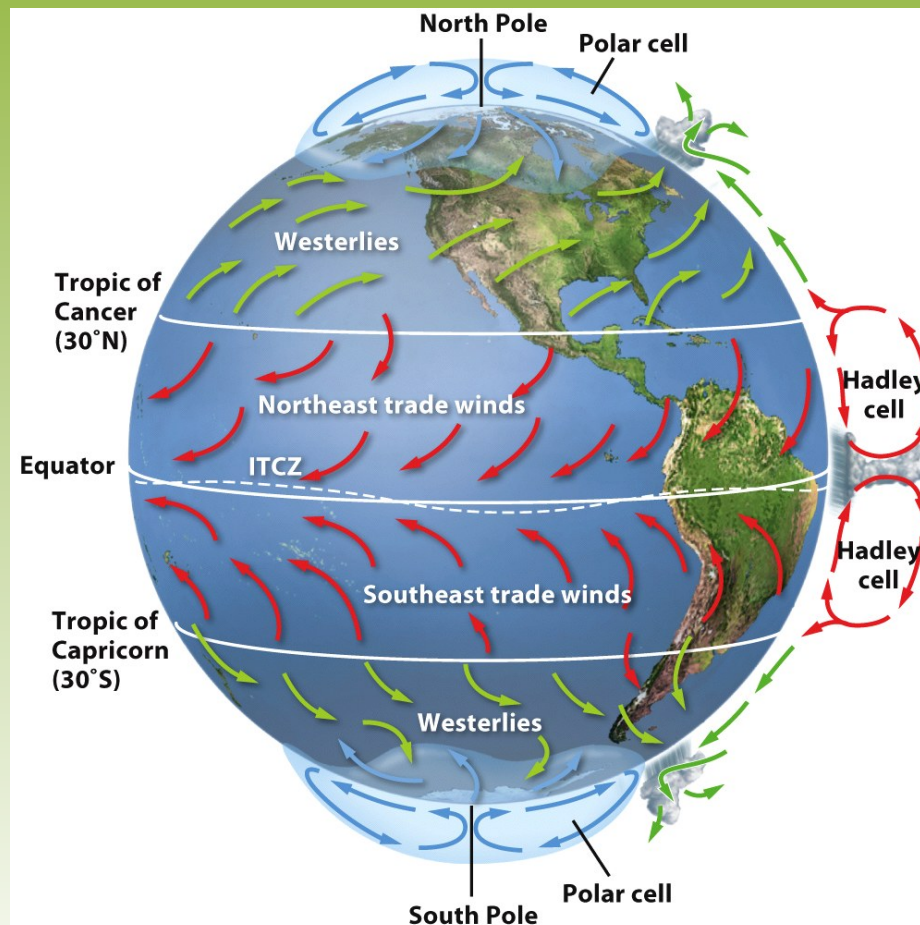
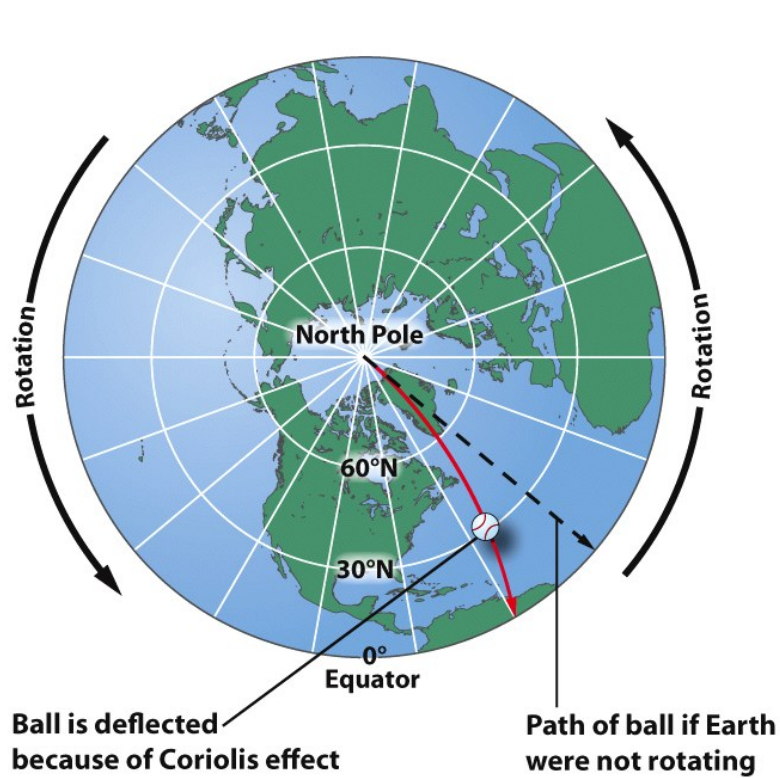


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Earth's Rotation and the Coriolis Effect

- As Earth rotates, its surface moves much faster at the equator than in mid-latitude and polar regions.
- The faster rotation speeds closer to the equator cause a deflection of objects that are moving directly north or south.

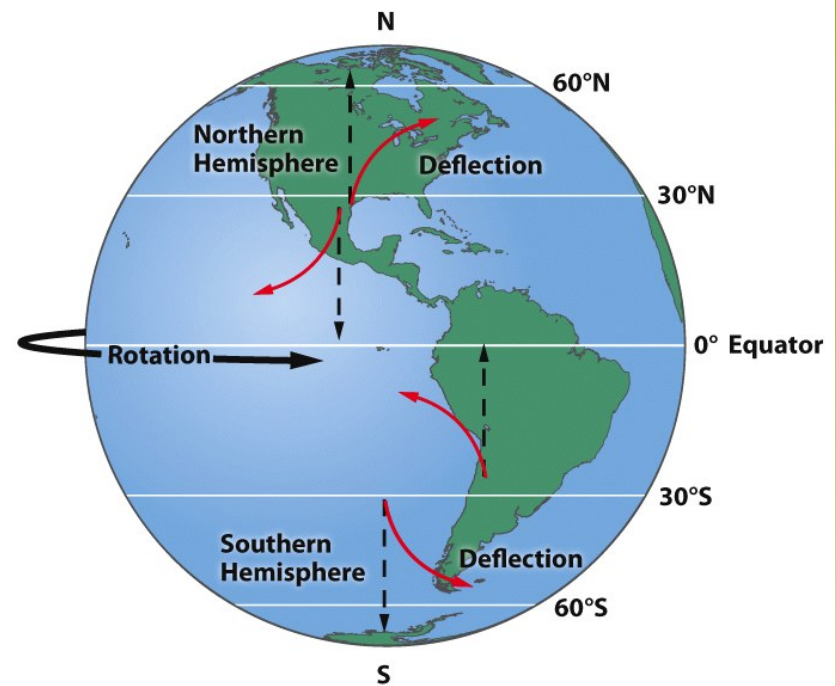


(a)

Figure 4.8

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(b)

Earth's Rotation and the Coriolis Effect

- Coriolis Effect- the deflection of an object's path due to Earth's rotation.
- The prevailing winds of the world are produced by a combination of atmospheric convection currents and the Coriolis effect.

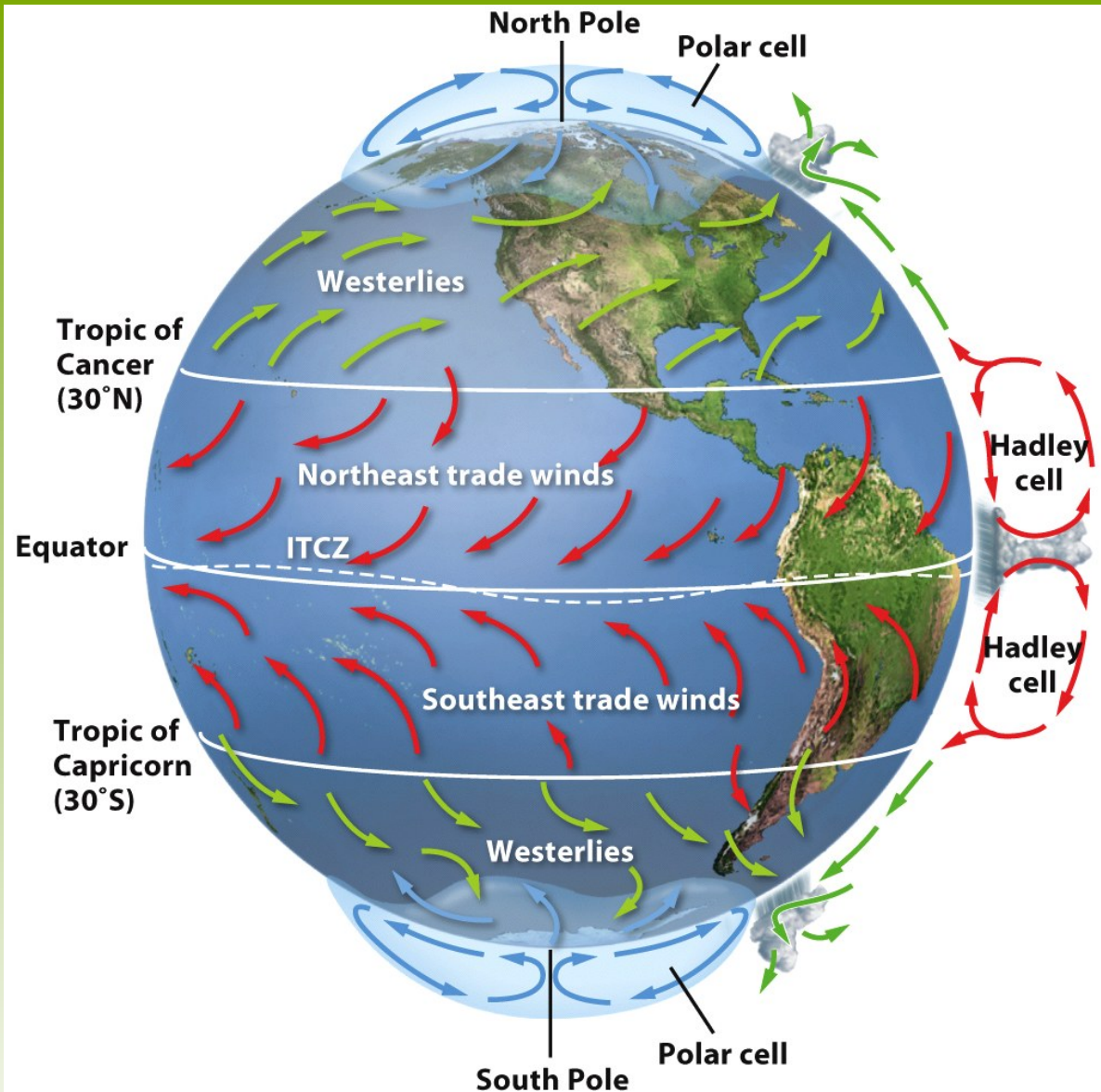


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Earth's Tilt combined with the trip around the Sun causes the Seasons

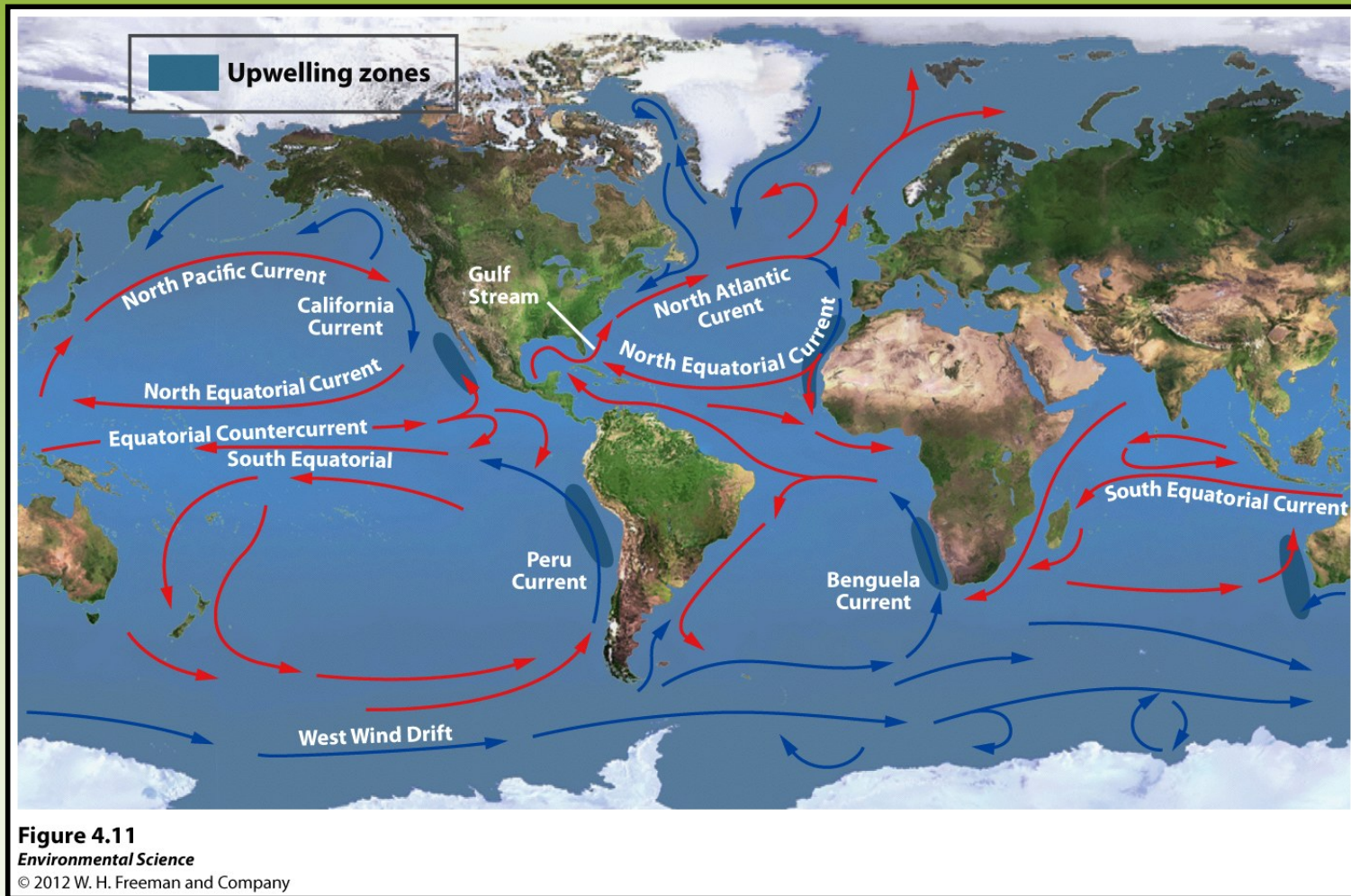
- The Earth's axis of rotation is tilted 23.5° .
- When the Northern Hemisphere is tilted toward the Sun, the Southern Hemisphere is tilted away from the Sun, and vice versa.

Ocean Currents

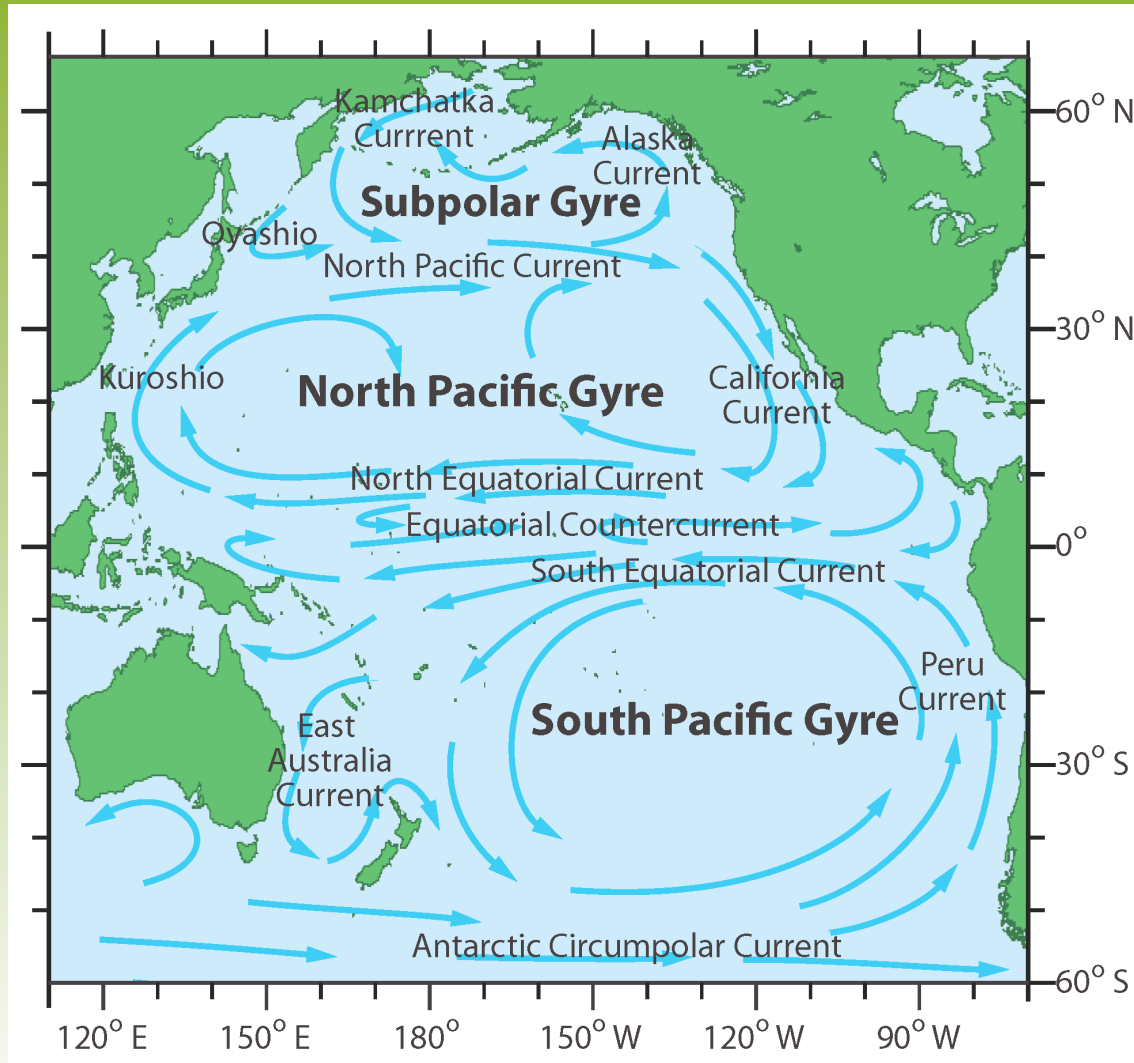
- Ocean currents are driven by a combination of temperature, gravity, prevailing winds, the Coriolis effect, and the locations of continents.
- Warm water, like warm air, expands and rises.
- Gyres- the large-scale patterns of water circulation. The ocean surface currents rotate in a clockwise direction in the Northern Hemisphere and a counterclockwise direction in the Southern Hemisphere.

General Ocean Circulation

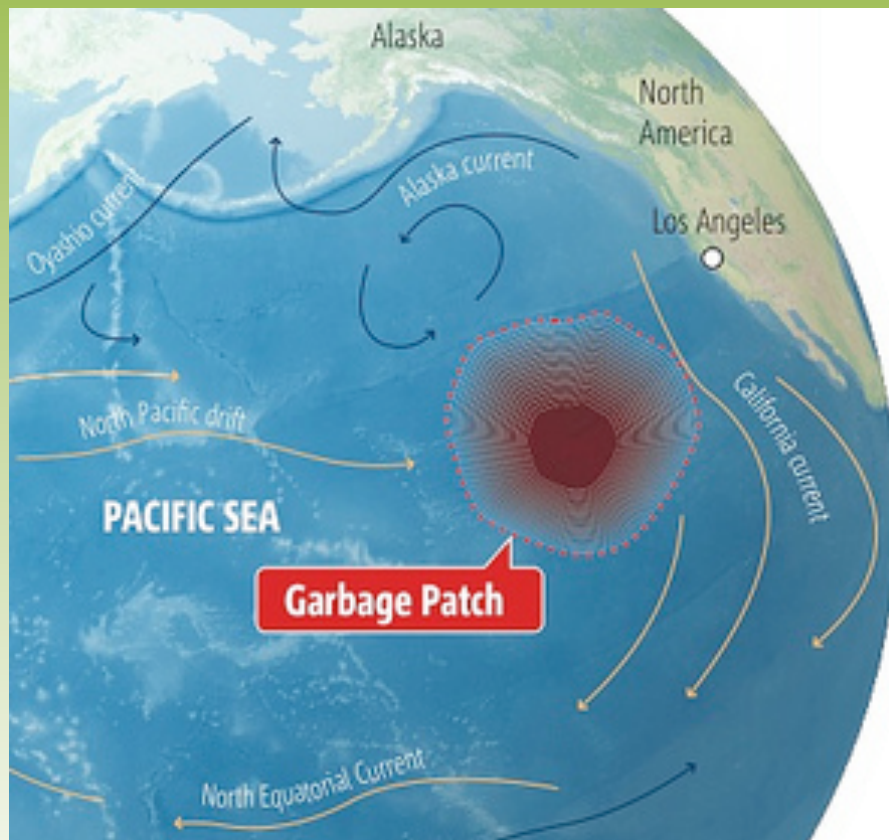
Warm Surface Currents and Cold Surface Currents



Gyres



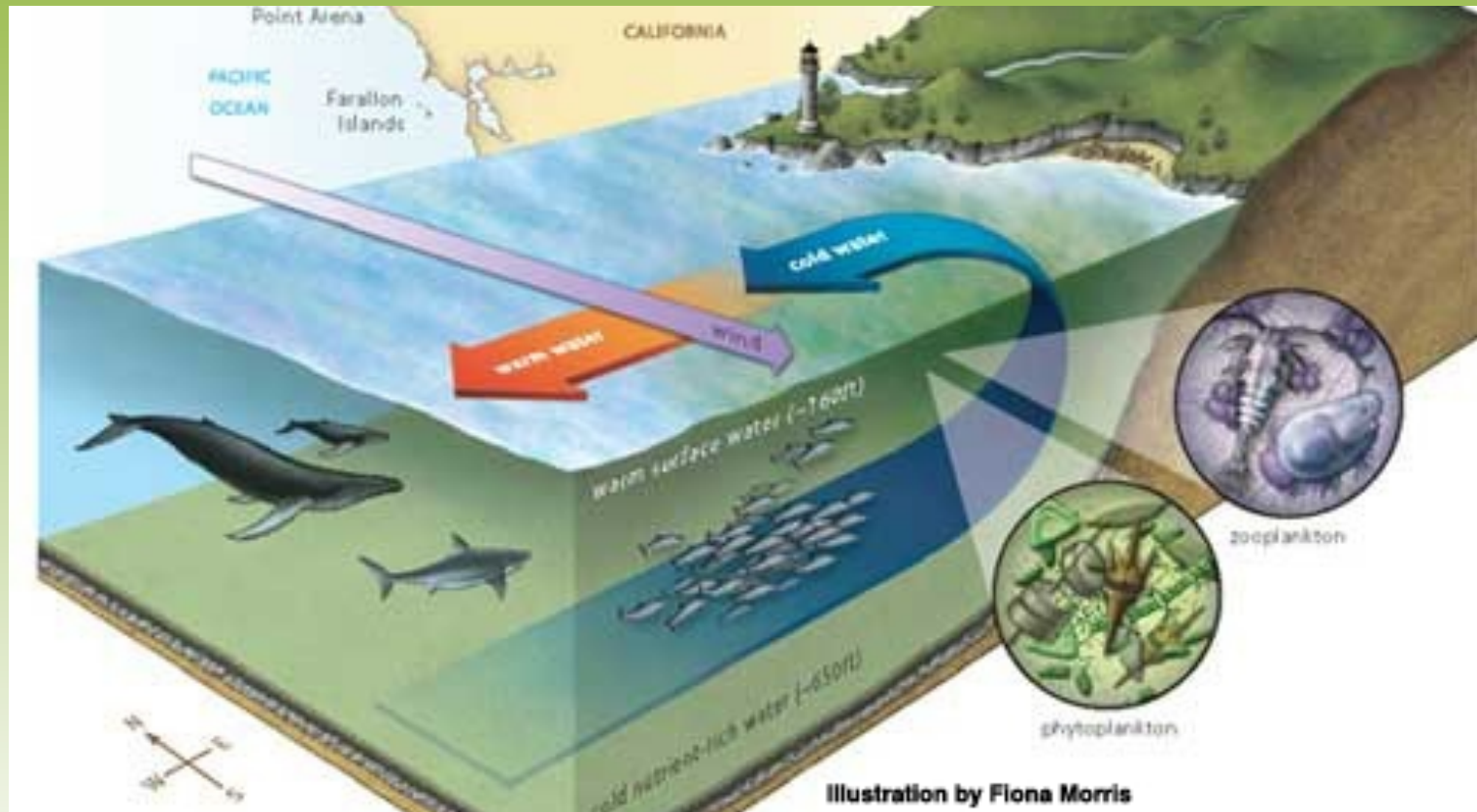
Pacific Garbage Gyre



Upwelling

- Upwelling- as the surface currents separate from one another, deeper waters rise and replace the water that has moved away.
- This upward movement of water brings nutrients from the ocean bottom that supports the large populations of producers, which in turn support large populations of fish.

Upwelling of cold, nutrient-rich water along coasts



Thermohaline Circulation

- Thermohaline circulation- another oceanic circulation that drives the mixing of surface water and deep water.
- Scientists believe this process is crucial for moving heat and nutrients around the globe.
- Thermohaline circulation appears to be driven by surface waters that contain unusually large amounts of salt.

Thermohaline Circulation

- Some of the water that flows from the Gulf of Mexico to the North Atlantic freezes or evaporates, and the salt that remains behind increases the salt concentration of the water.
- This cold, salty water is relatively dense, so it sinks to the bottom of the ocean, mixing with deeper ocean waters.
- These two processes create the movement necessary to drive a deep, cold current that slowly moves past Antarctica and northward to the northern Pacific Ocean.

The Global Oceanic Conveyor Belt

1 Warm water flows from the Gulf of Mexico to the North Atlantic, where some of it freezes and evaporates.

2 The remaining water, now saltier and denser, sinks to the ocean bottom.

3 The cold water travels along the ocean floor, connecting the world's oceans.

4 The cold, deep water eventually rises to the surface and circulates back to the North Atlantic.

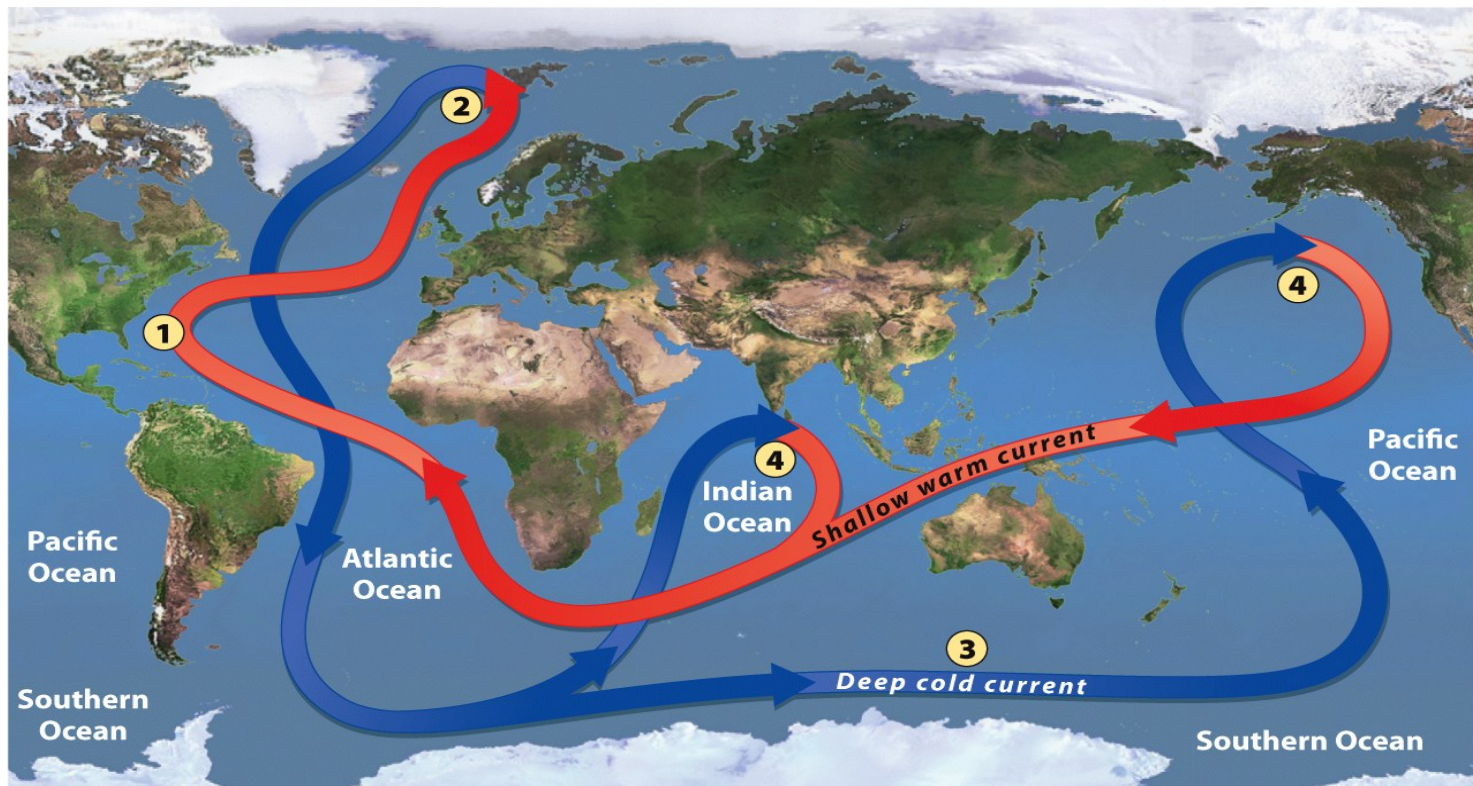


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Heat Transport

- Ocean currents can affect the temperature of nearby landmasses.
- For example, England's average winter temperature is approximately 20 ° C (36°F) warmer than Newfoundland, Canada, which is located at a similar latitude.

El Niño-Southern Oscillation

- 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.

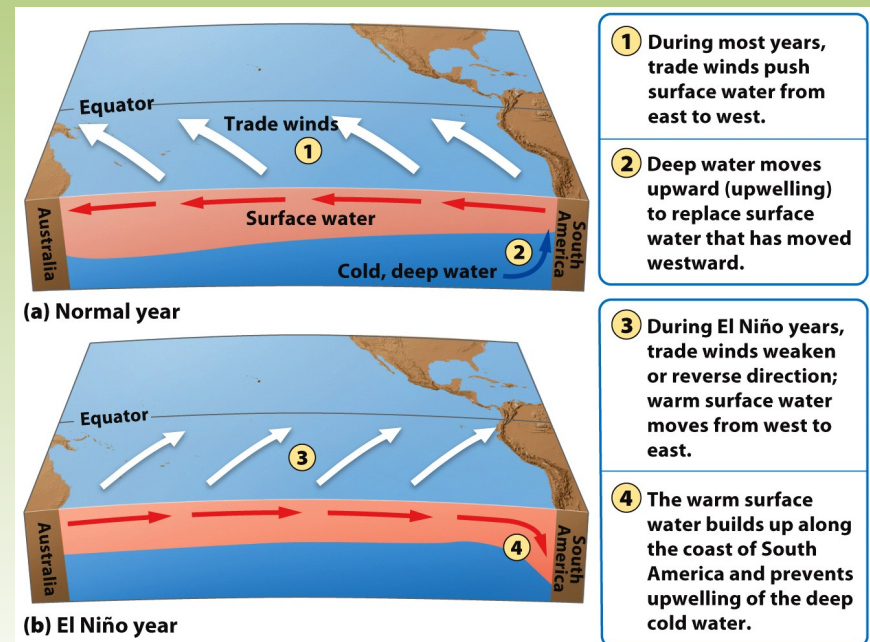
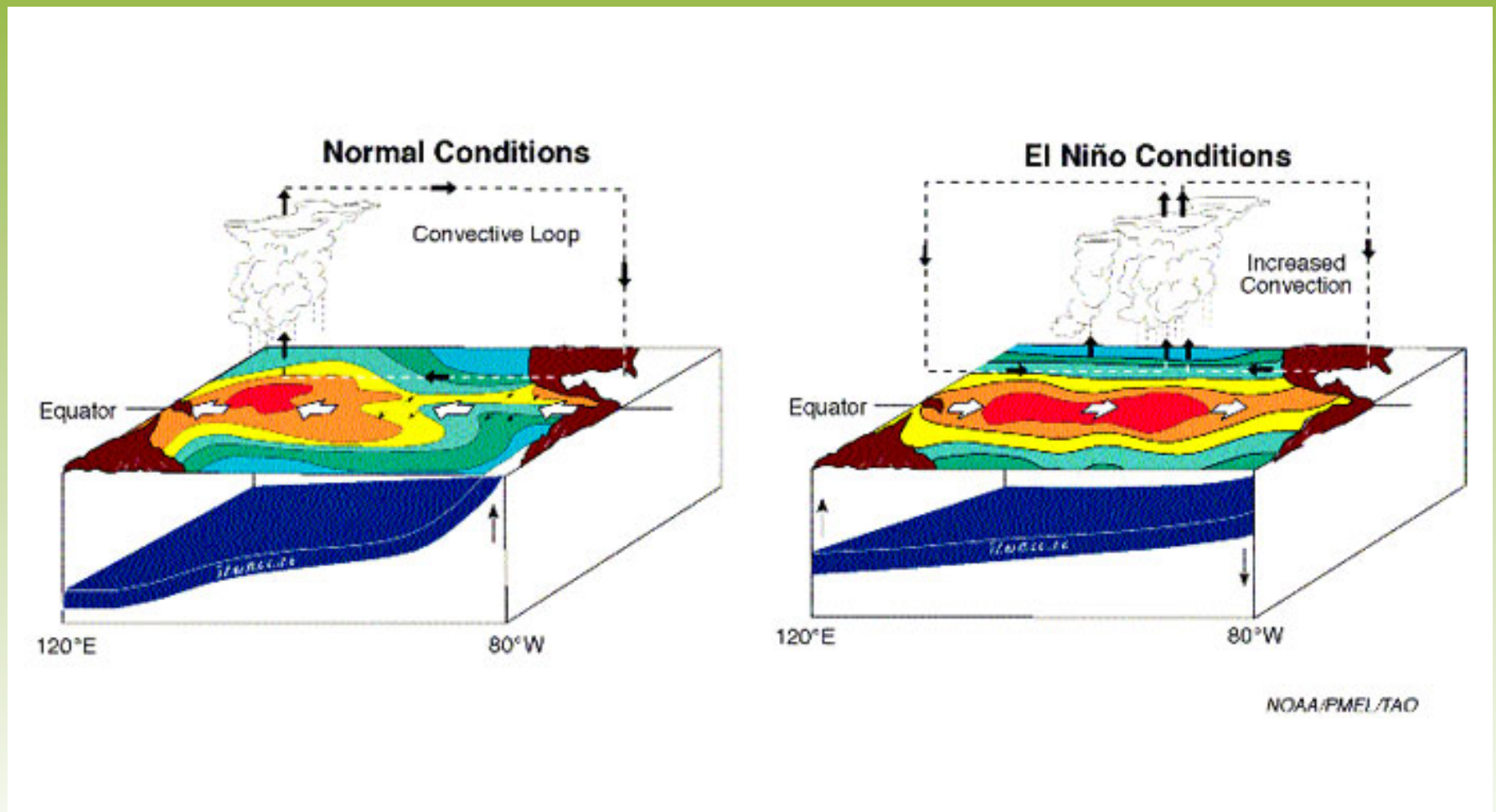


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El Nino-Southern Oscillation

- 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.

El Niño-Southern Oscillation ENSO



Rain Shadows

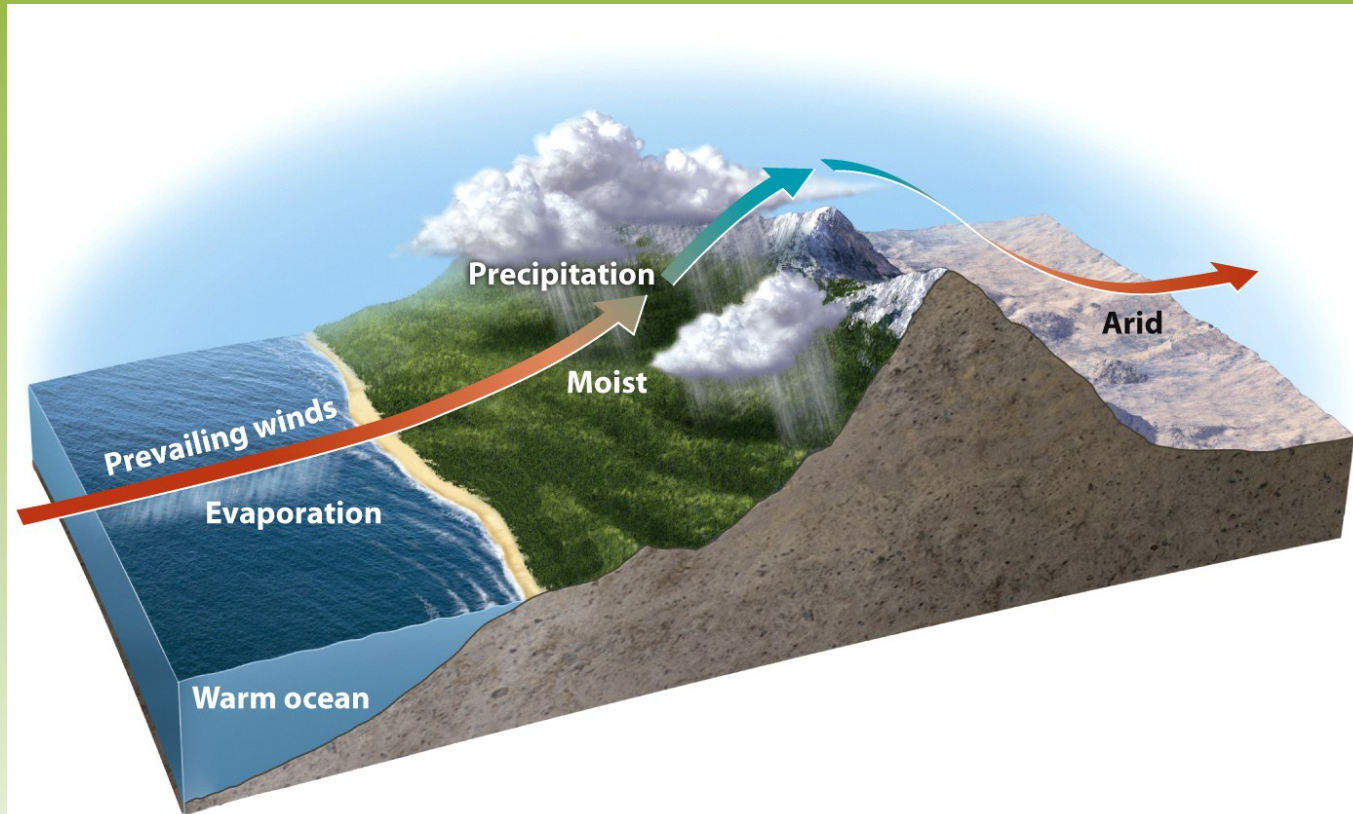


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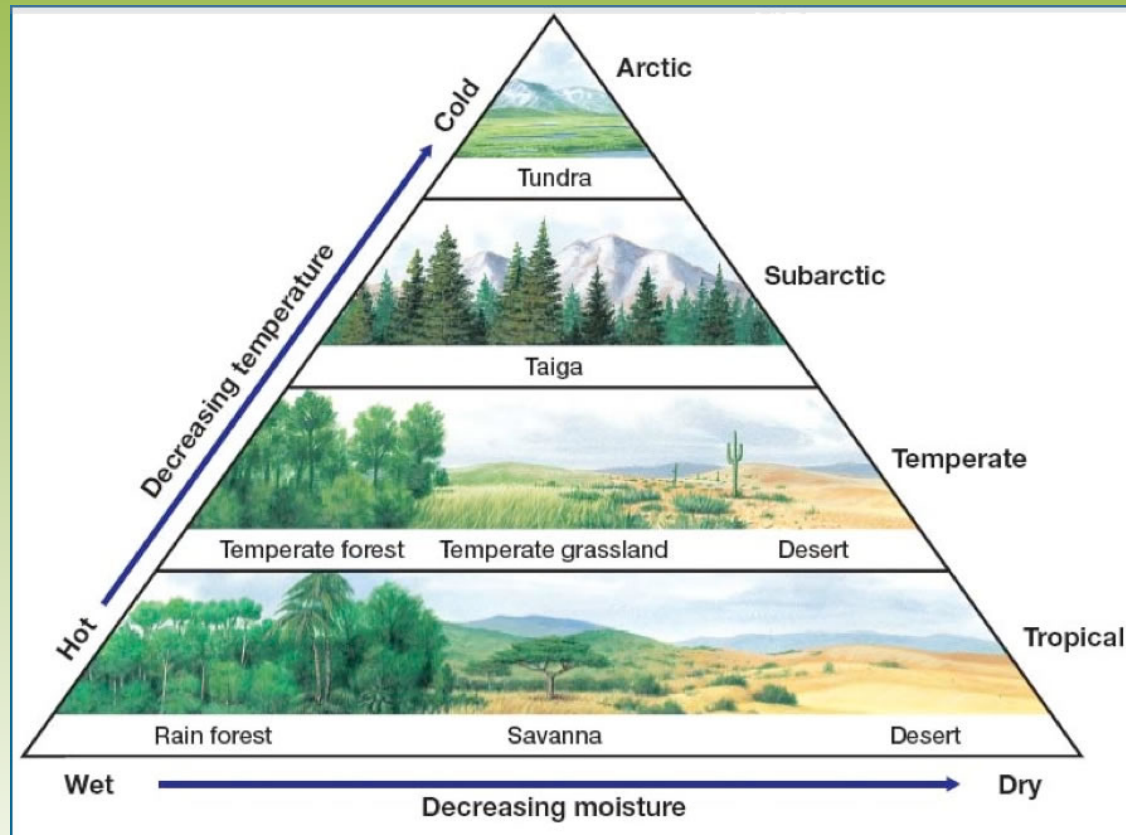
Rain Shadows

- When air moving inland from the ocean that contains a large amount of water vapor meets the windward side of a mountain range (the side facing the wind), it rises and begins to experience adiabatic cooling.
- Because water vapor condenses as air cools, clouds form and precipitation falls.
- The presence of the mountain range causes large amounts of precipitation to fall on its windward side.
- The cold, dry air then travels to the other side of the mountain range (the leeward side), where it descends and experiences higher pressures, which cause adiabatic heating.
- This air is now warm and dry and process arid conditions on the leeward side forming the region called a rain shadow.

Variations in Climate Determine the Dominant Plant Growth Forms of Terrestrial Biomes

- 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.

The Biome Triangle



Terrestrial Biomes

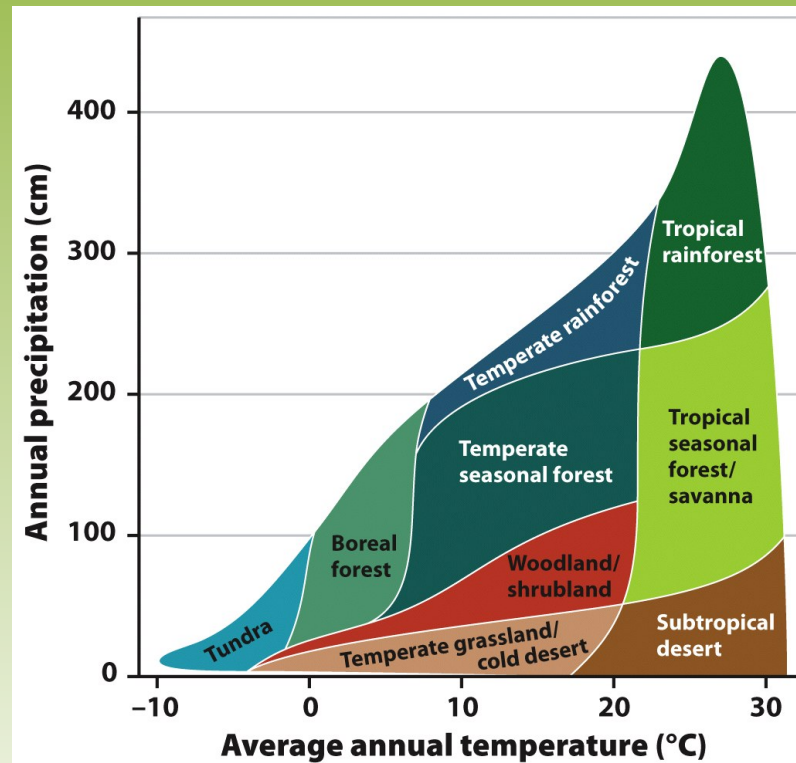


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Tundra

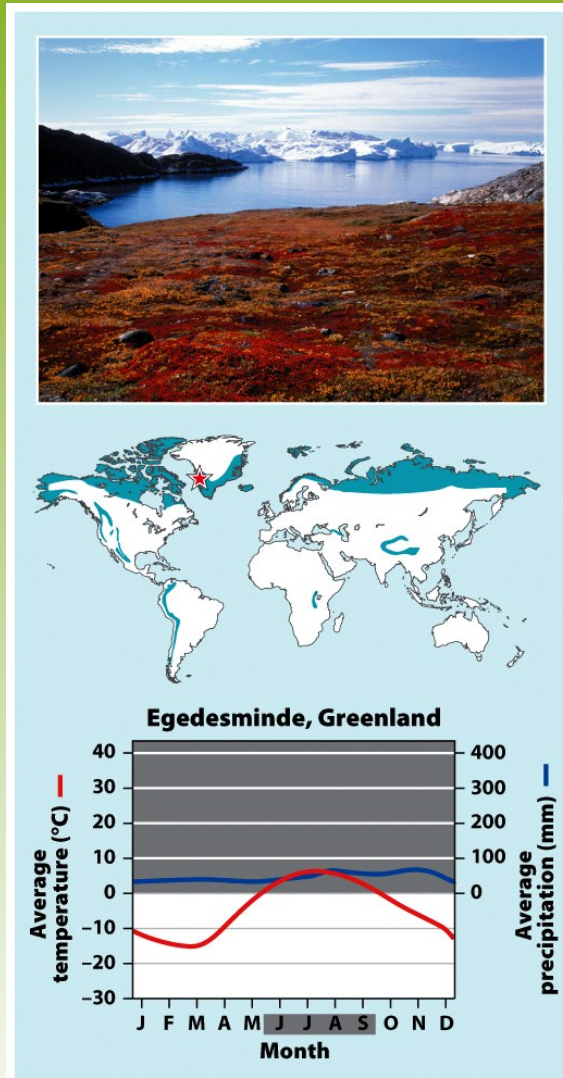


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Boreal Forest

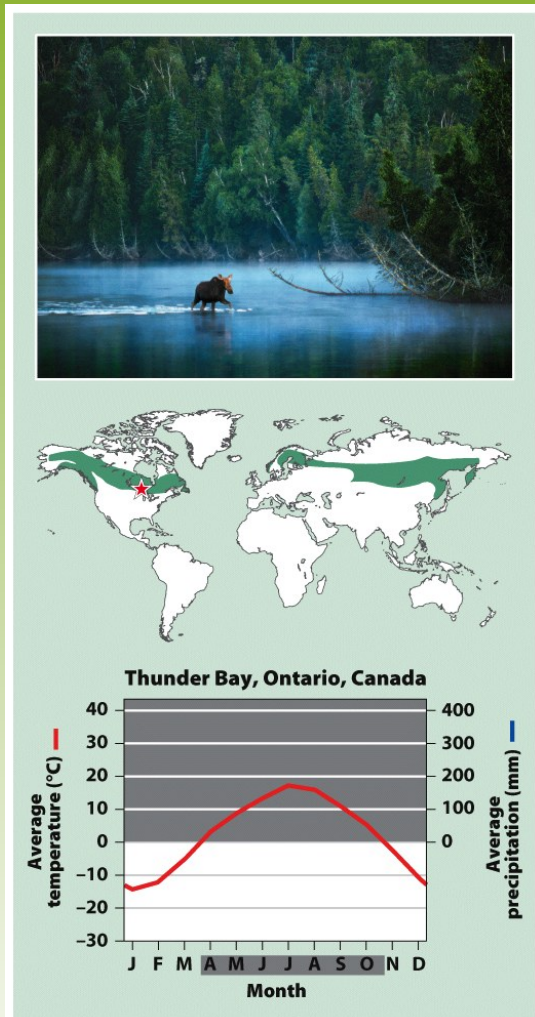
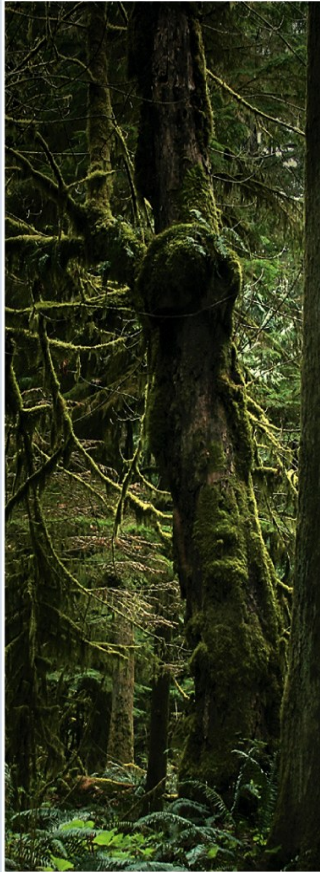


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Temperate Rainforest



Nanaimo Departure Bay, British Columbia, Canada

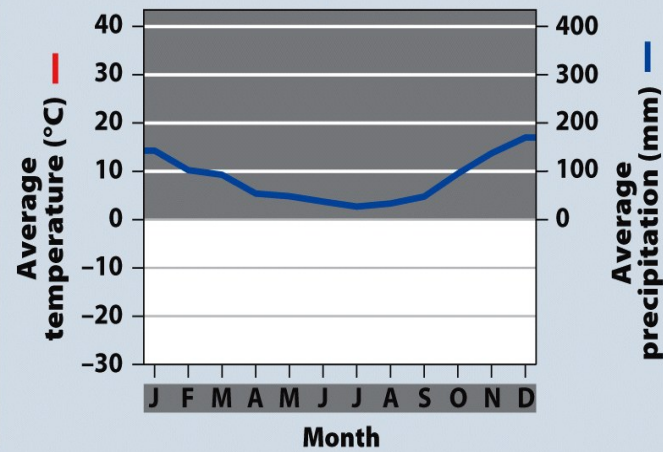


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Temperate Seasonal Forest

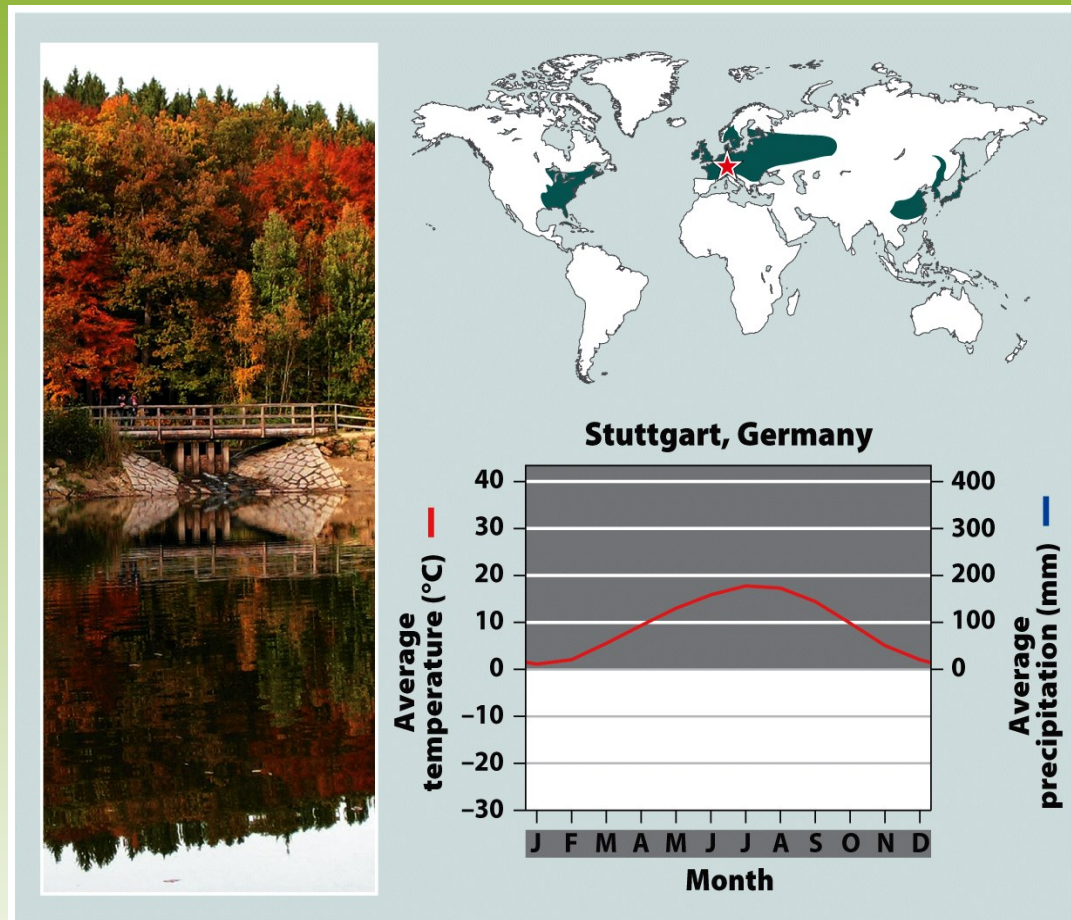


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Temperate Seasonal Forest



Woodland/Shrubland

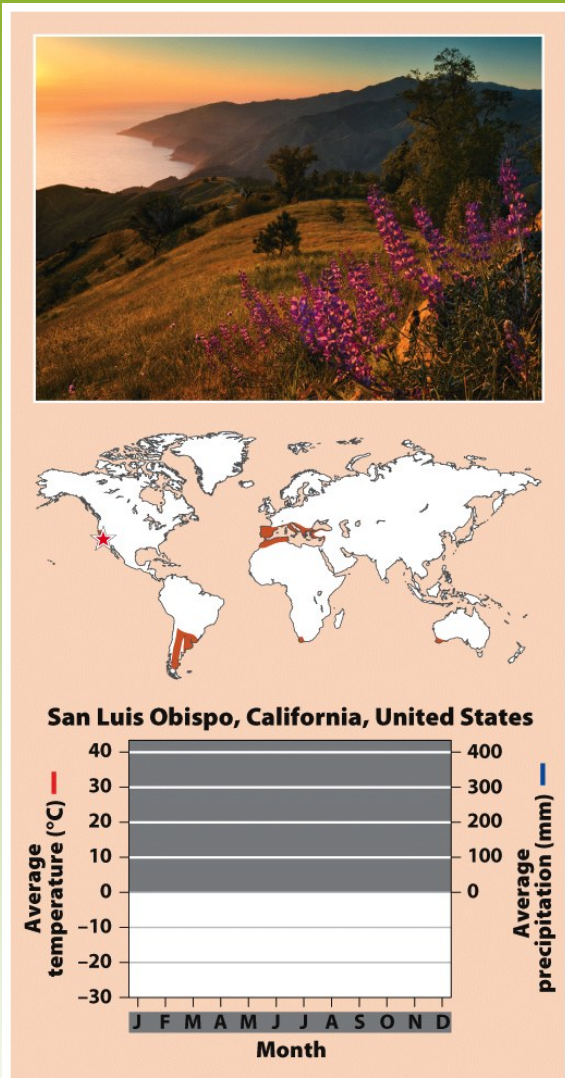
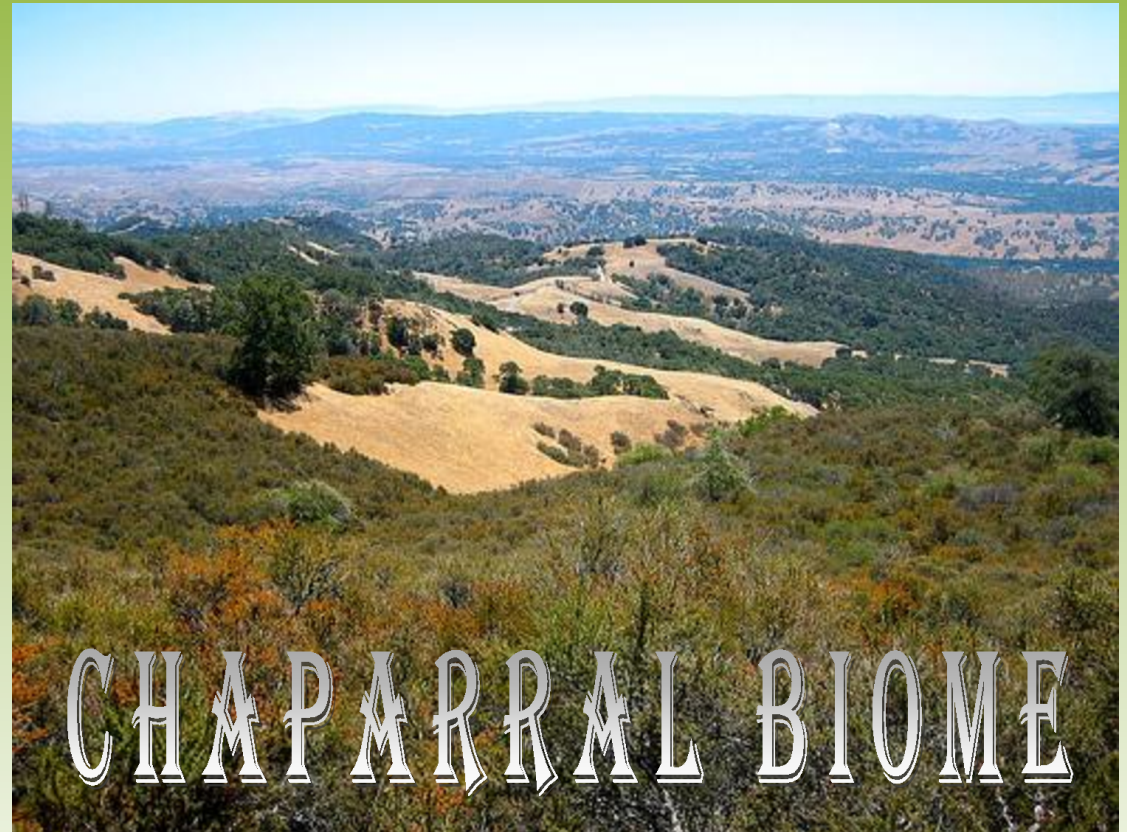


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Temperate Grassland/Cold Desert

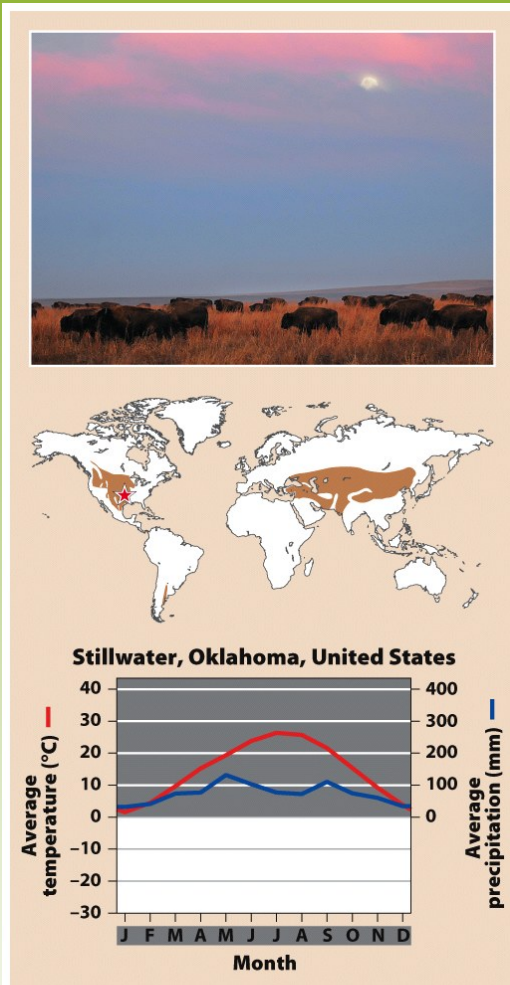
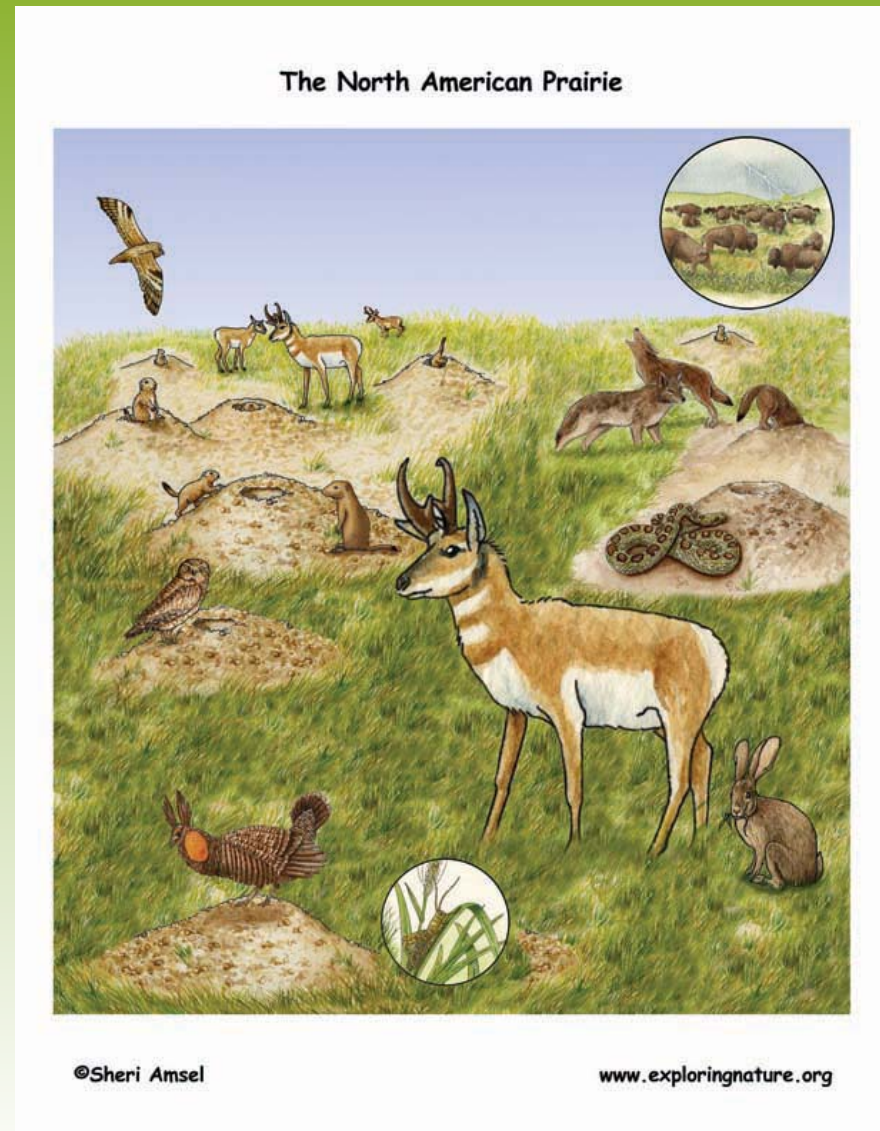


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Tropical Rainforest

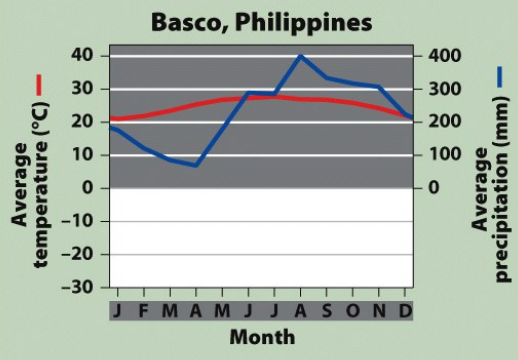


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Tropical Seasonal Forest/Savanna

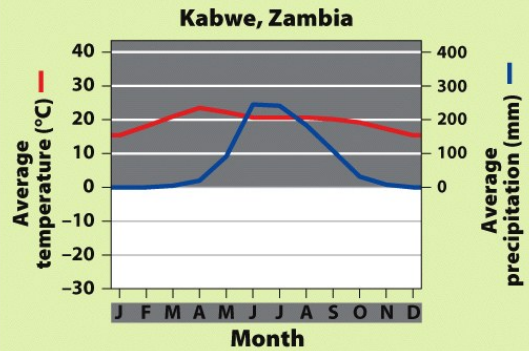


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Subtropical Desert

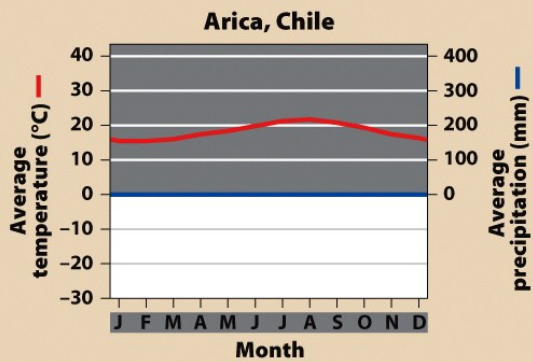
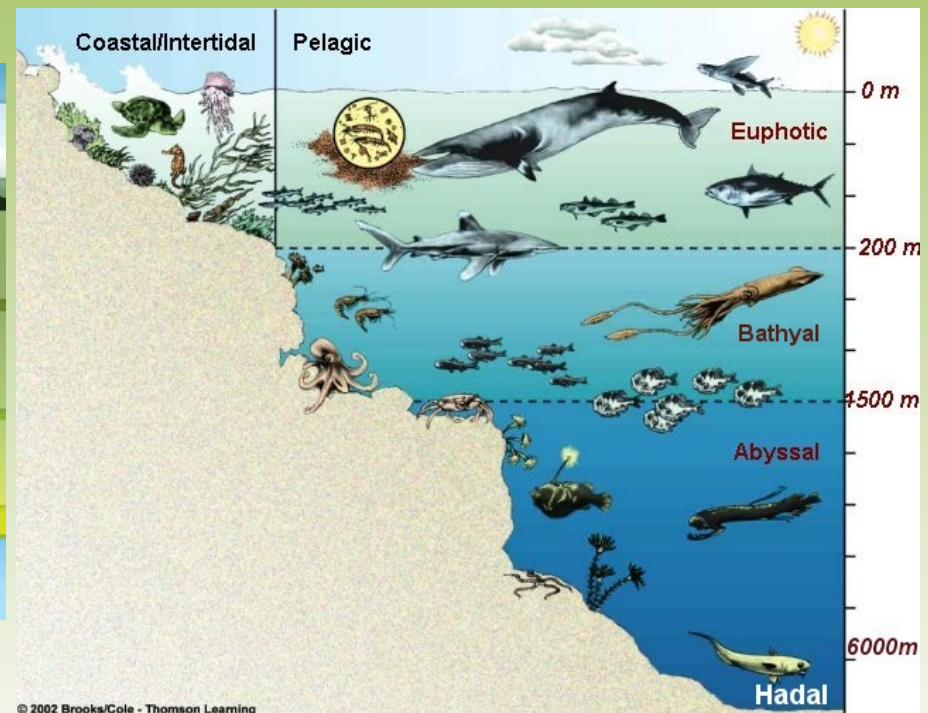


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Aquatic Biomes are Categorized by Salinity, Depth, and Water Flow



Streams and Rivers

- Flowing fresh water that may originate from underground springs or as runoff from rain or melting snow.
- Streams are typically narrow and carry relatively small amounts of water where rivers are usually wider and carry larger amounts of water.



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Lakes and Ponds

- Standing water that some of which is too deep to support emergent vegetation.
- Lakes are larger than ponds but there is no clear point at which a pond is considered large enough to be called a lake.

Lakes and Ponds



Lake George, Adirondack Park, New York

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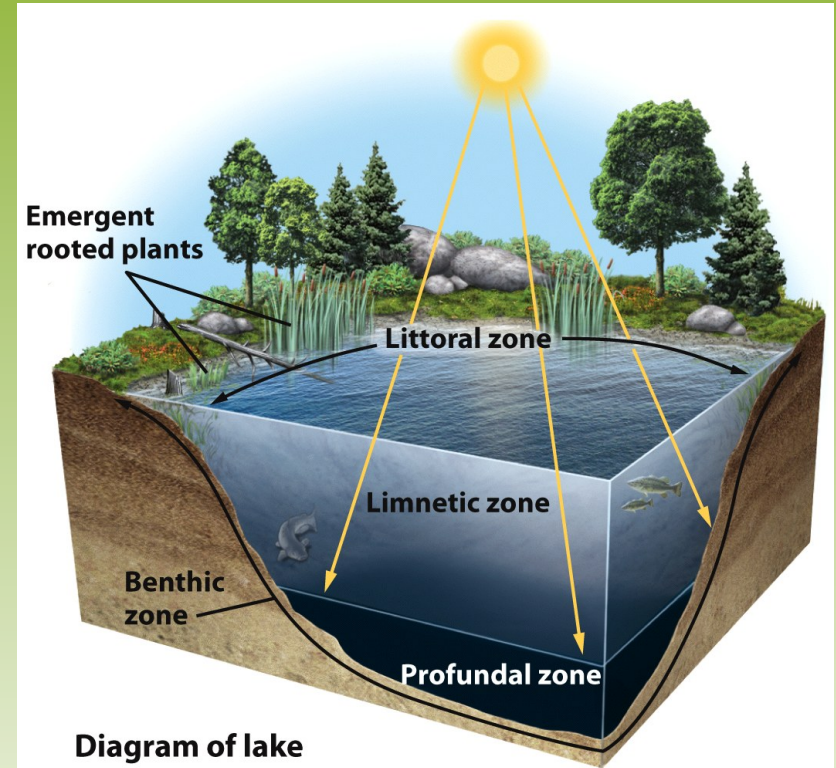


Diagram of lake

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Lakes and Ponds

- Littoral zone- the shallow area of soil and water near the shore where algae and emergent plants grow.
- Limnetic zone- open water, where rooted plants can no longer survive. Phytoplankton are the only photosynthetic organisms. This zone extends to as deep as sunlight can penetrate.
- Profundal zone- the zone where sunlight cannot penetrate and therefore producers cannot survive.
- Benthic zone- the muddy bottom of a lake or pond beneath the limnetic and profundal zone.

Freshwater Wetlands

- Aquatic biomes that are submerged or saturated by water for at least part of each year, but shallow enough to support emergent vegetation.
- These include swamps, marshes, and bogs.

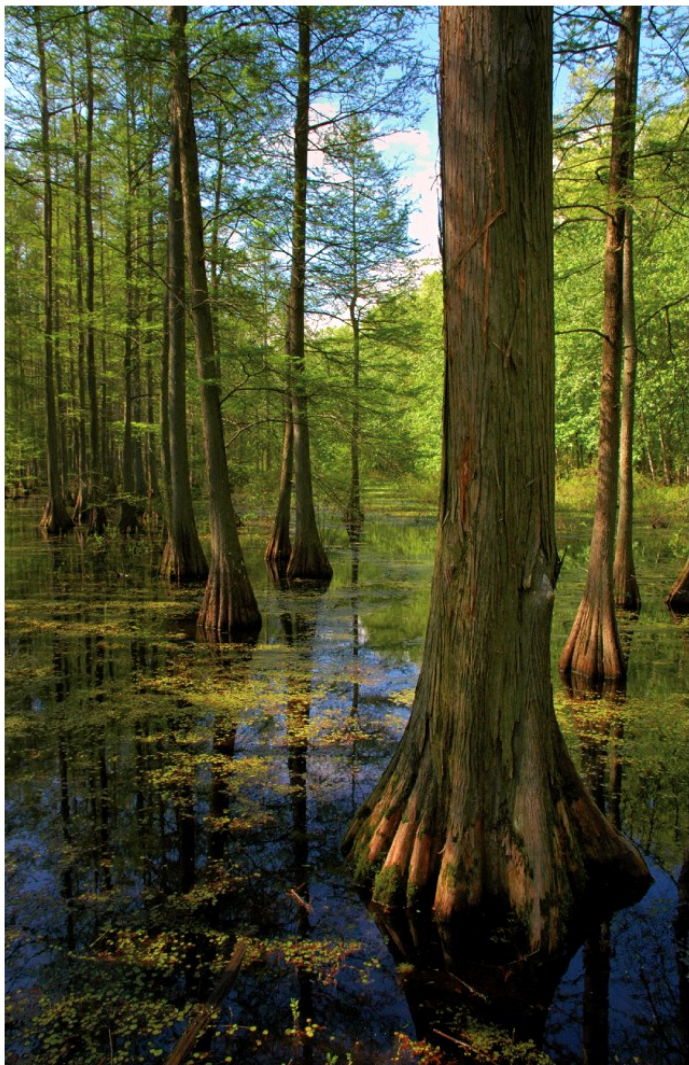


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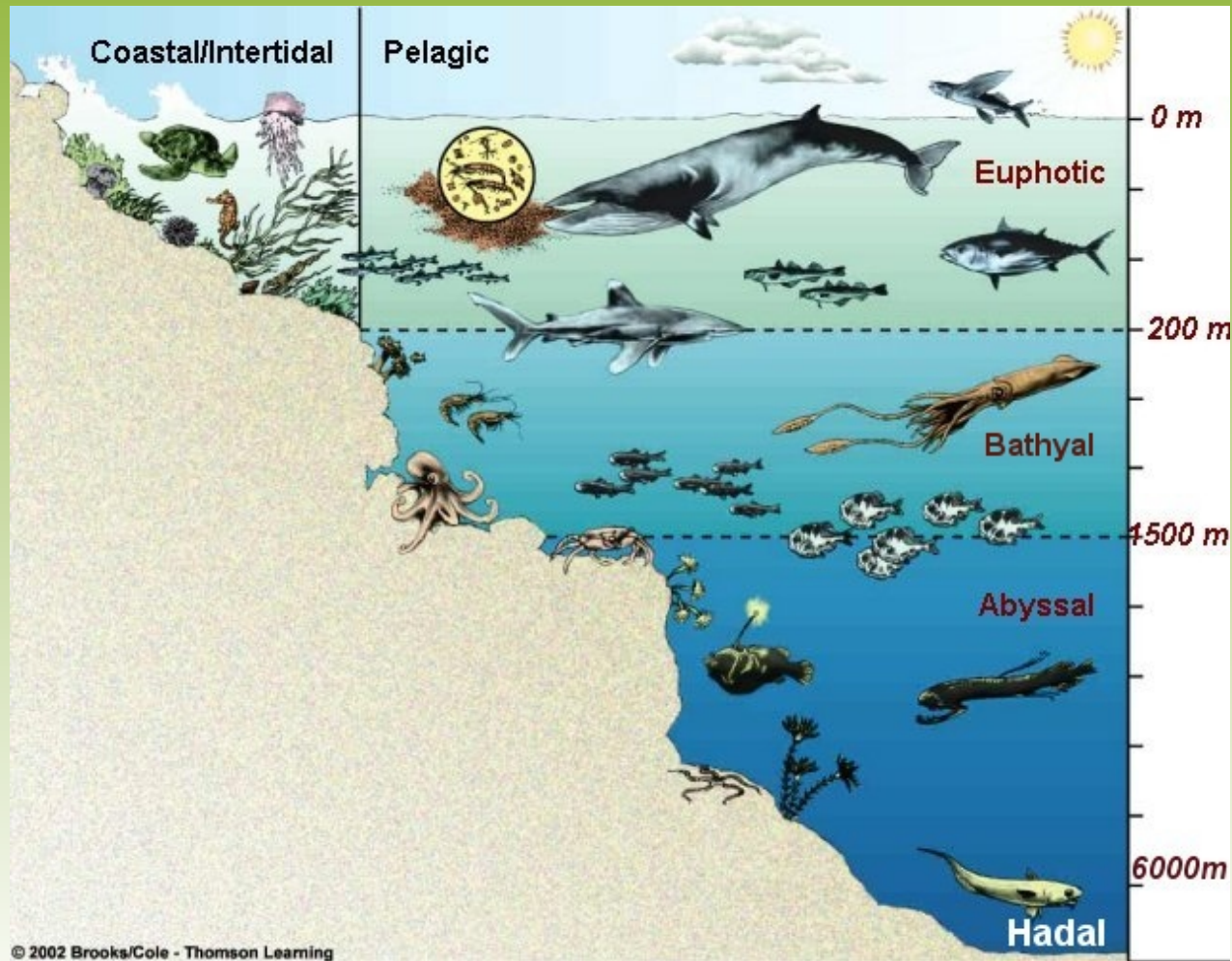


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Marine Life Zones



Salt Marshes

- Found along the coast in temperate climates and contain non woody emergent vegetation.
- The salt marsh is one of the most productive biomes in the world.



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Mangrove Swamps

- Found along tropical and subtropical coasts and contain trees whose roots are submerged in water.
- Mangrove trees are salt tolerant and help protect the coastlines from erosion and storm damage.



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Figure 4.32

Intertidal Zone

- Narrow band of coastline that exists between the levels of high tide and low tide.
- Waves that crash onto the shore in this biome can make it a challenge for organisms to hold on and not get washed away.



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Figure 4.33

Coral Reefs

- Found in warm, shallow waters beyond the shoreline.
- Earth's most diverse marine biome even though coral reefs are found in water that is relatively poor in nutrients and food.
- Coral bleaching- when the algae inside the coral dies. Scientists believe this is due to a combination of disease and environmental change.



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The Open Ocean

- The depth that light can penetrate in the open ocean is dependent on the amount of sediment and algae suspended in the water.
- Photic zone- the zone that receives enough light to allow photosynthesis to occur.
- Aphotic zone- the deeper water that lacks sufficient light for photosynthesis.
- Chemosynthesis- The process that occurs in the aphotic zone when some species of bacteria use methane and hydrogen sulfide to generate energy.

Open Ocean Photic Zone



Open Ocean... Aphotic Zone



Sustainable Coffee?



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