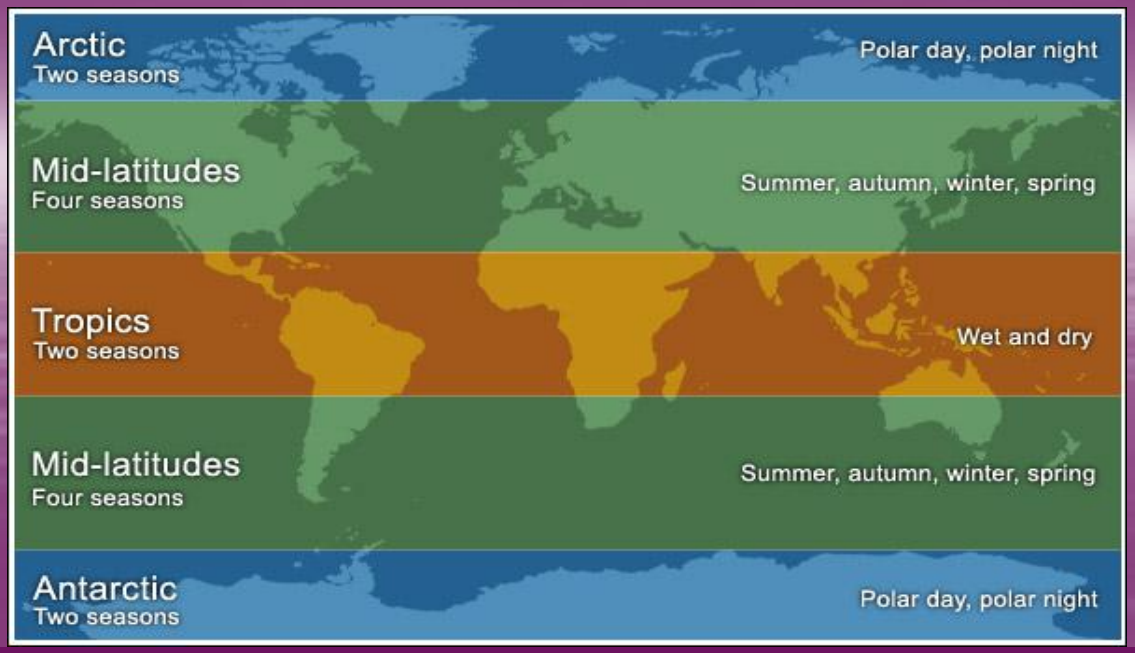
Lesson 1- Air Masses

- The unequal heating of Earth's surface creates differences in air pressure and different seasons.
- Differences occur because the Earth is round which means the equator receives more solar energy than the regions at the poles.

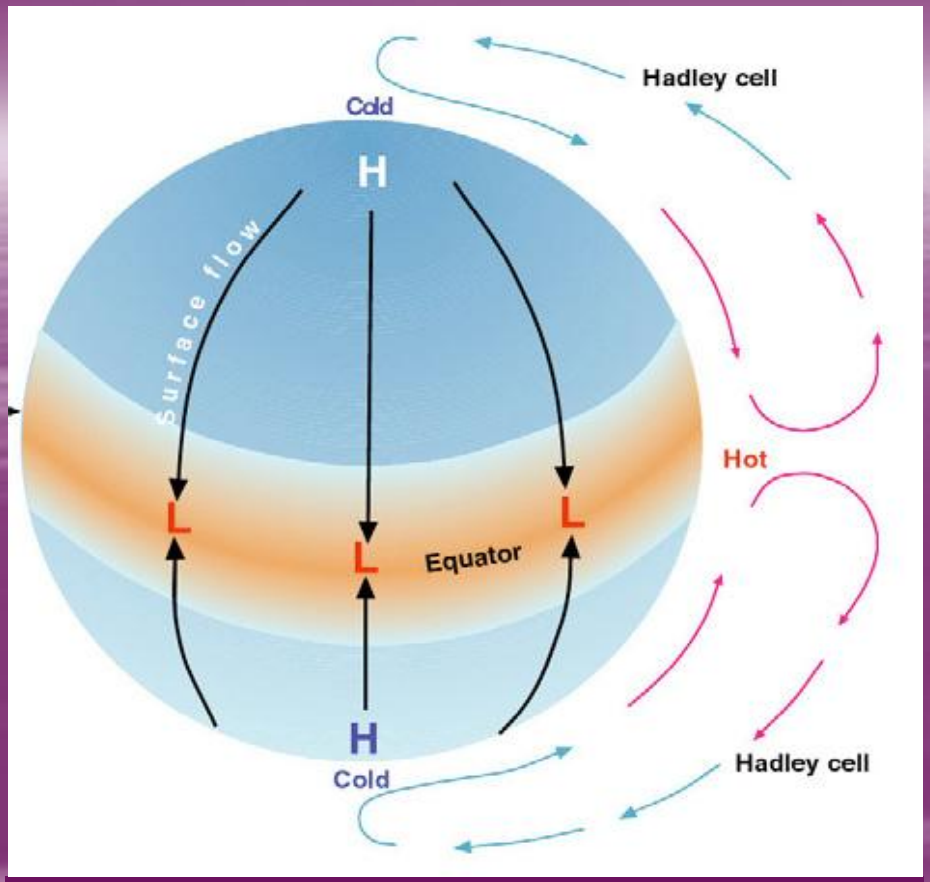
Chapter menu Resources

Seasons



- The Mid-latitudes are the only places that experience four seasons.
- Tropics have no noticeable change in the amount of sunlight so weather is consistent.
- Arctic area's experience two seasons called day and night.

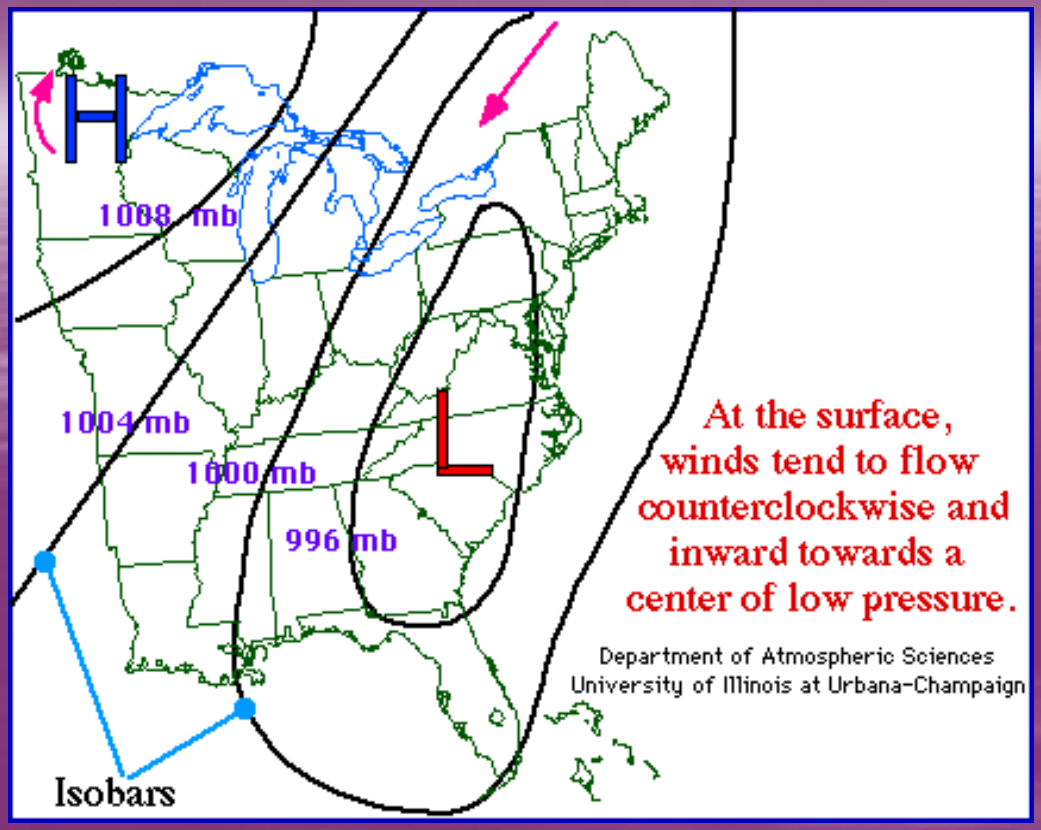
Chapter menu
Resources



Difference in Air Pressure

- The difference in air pressure creates Wind patterns and large thermally driven convection cells.

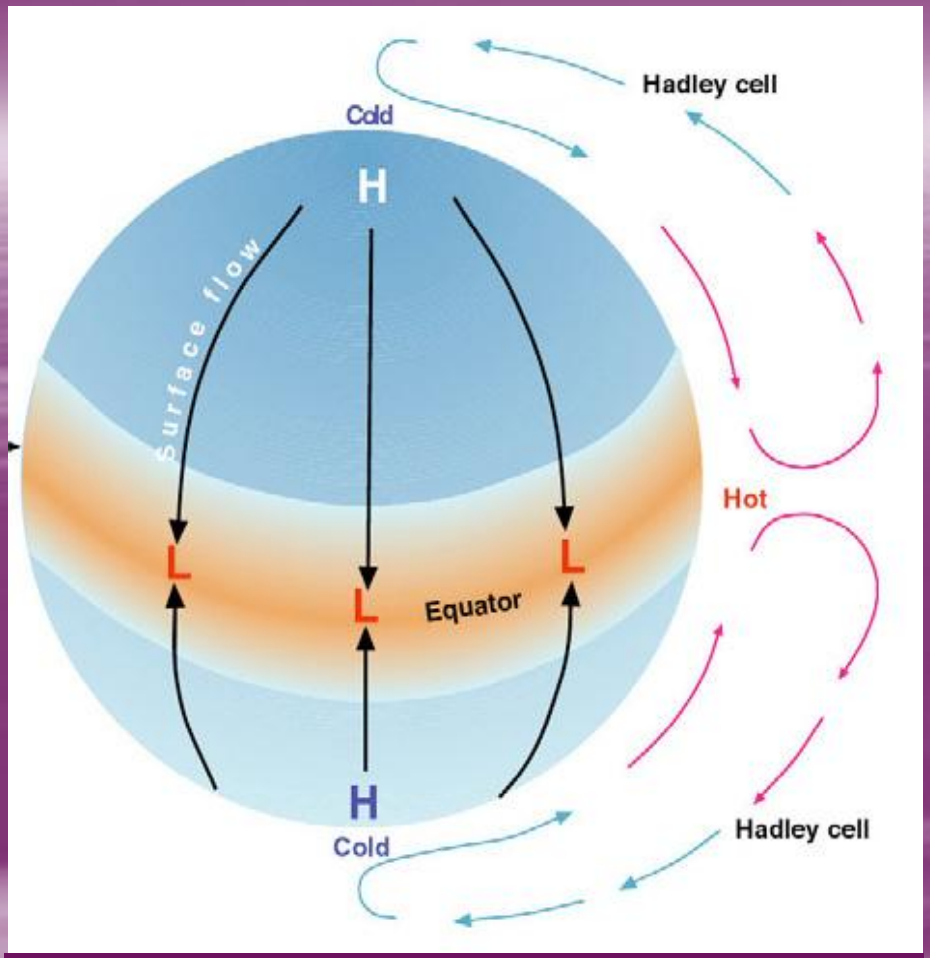
Chapter menu
Resources



- Cold air near the poles will sink and creates high-pressure centers.
- Air moves from areas of high pressure to areas of low pressure.

Difference in Air Pressure

Chapter menu
Resources

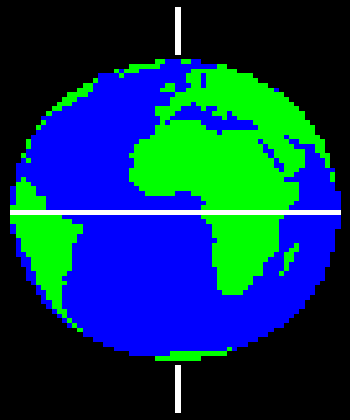


The Single Cell Model

- This means cooled air should move from the poles moves toward the equator.
- Heated air from the equator moves to the poles (Single Cell Model).

Chapter menu
Resources

The Earth rotates from West to East



- Complicated by:

- (1) Earth rotates (Coriolis Effect).
- (2) Earth has a tilt of 23.5°.
- (3) More continental land North than in the South.

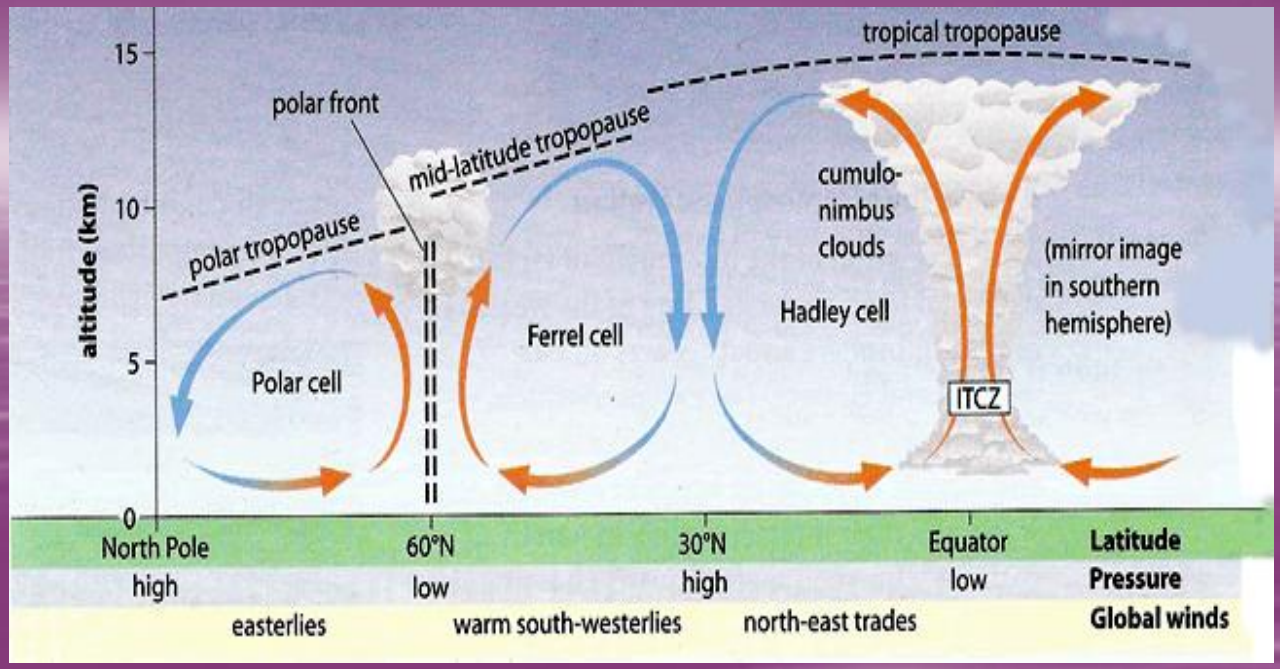
Flaws with the Single Cell Model

Chapter menu Resources

Check for Understanding

- Why do seasons vary depending upon the latitudinal location?

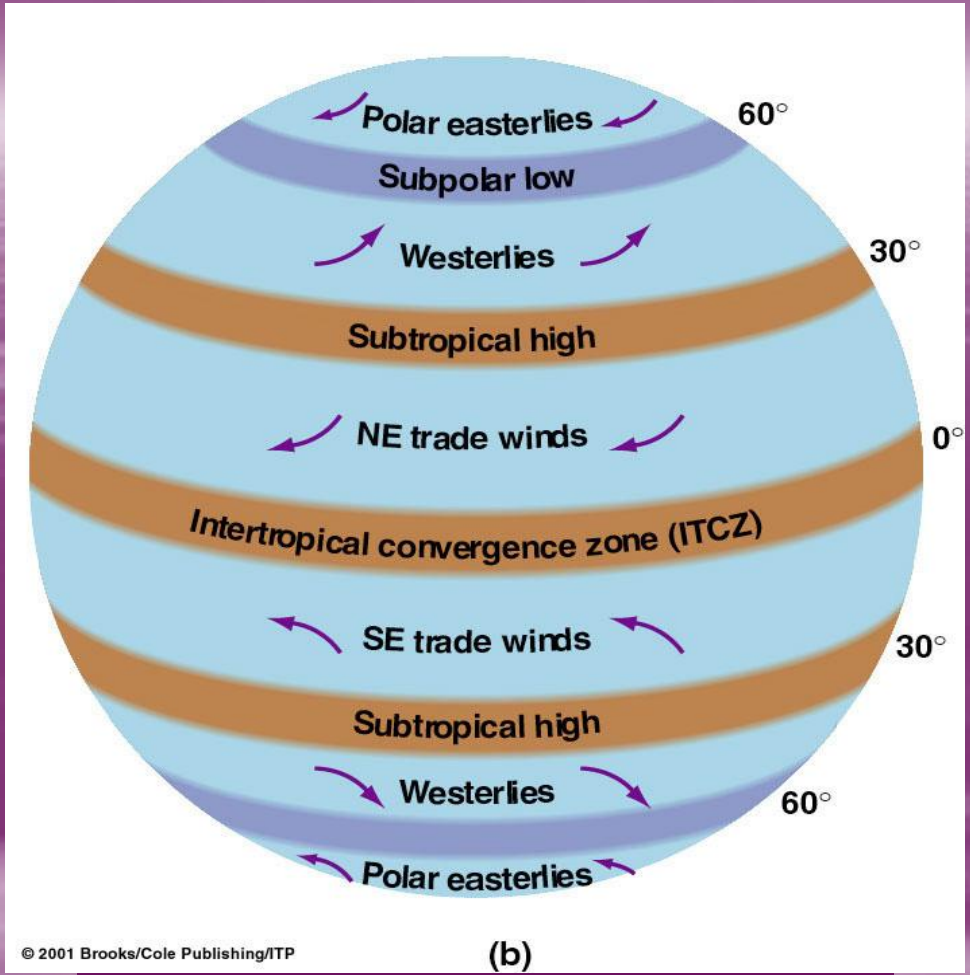
Three Cell Model



- Due to these complications, the global model consist of three circulation cells in each hemisphere.

- These three cells are known as the:
- (1) Tropical cell – Powered by the Trade Winds
- (2) Mid-Latitude cell – Powered By the Westerlies
- (3) Polar cell – Powered by the Polar Easterlies

Chapter menu
Resources



- (1) Trade winds
- (2) Westerlies,
- (3) Polar easterlies.

How Air Moves

Chapter menu
Resources

- If air remains stationary or moves slowly over a uniform region, the air takes on characteristic temperature and humidity of that region.

Formation of Air Masses

Formation of Air Masses

- Air masses that form over frozen polar regions are very cold and dry.

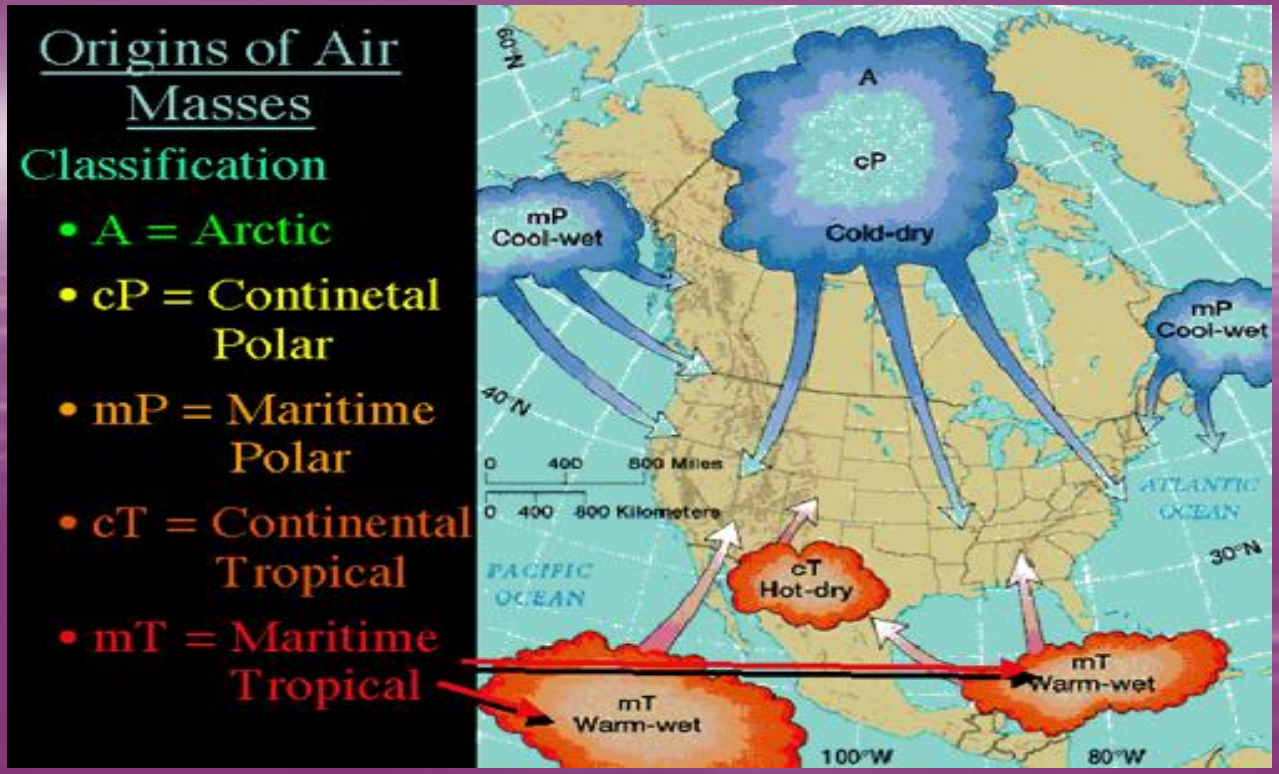
Chapter menu Resources

Formation of Air Masses

- Air masses that form over tropical oceans are warm and moist.

Chapter menu Resources

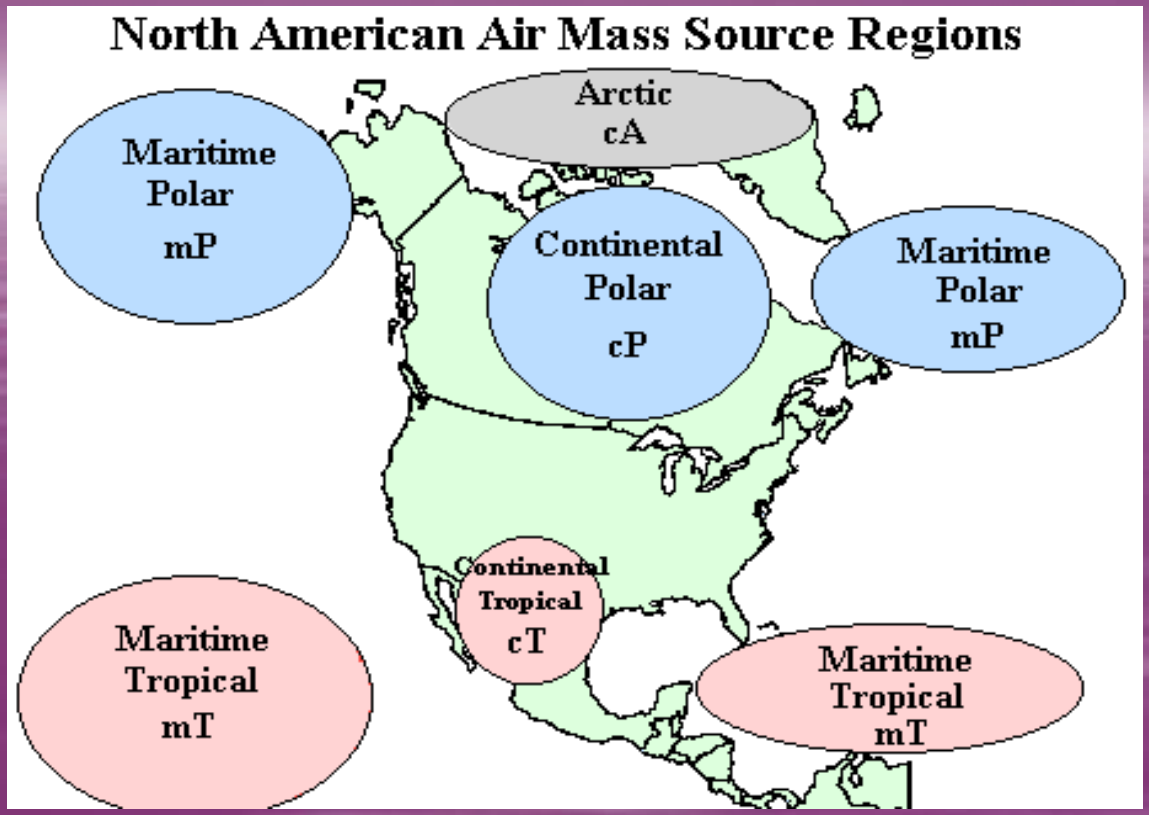
Classification of Air Masses



- Air masses are classified according to their source regions.

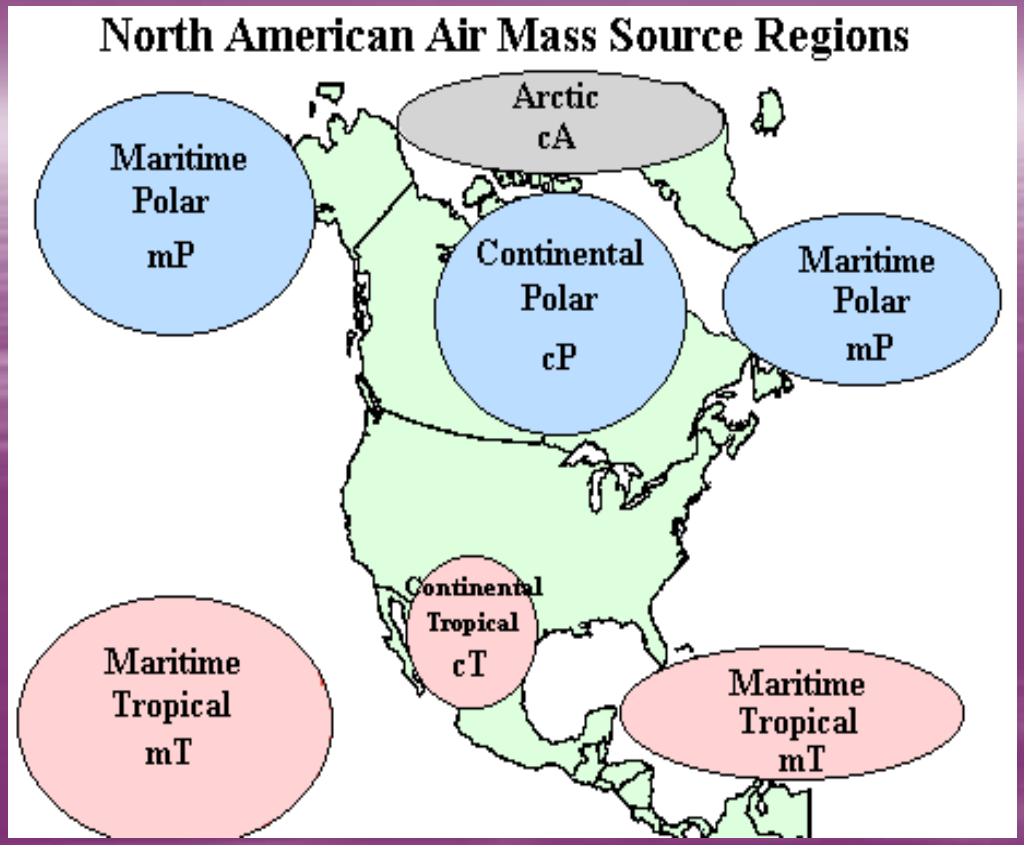
Chapter menu
Resources

Classification of Air Masses



- Source regions for cold air masses are polar areas.
- Source regions for warm air masses are tropical areas.

Chapter menu
Resources



- Air masses that form over the ocean are called *maritime*.
- Air masses that form over land are called *continental*.

Classification of Air Masses

Air Mass Chart

Summary of Air Mass Features

	Continental Arctic	Maritime Arctic	Continental Polar	Maritime Polar	Maritime Tropical	Continental Tropical
Temperature	very cold	cold	cold	cool	hot	very hot
Level of Moisture	dry	moist	dry	moist	moist	dry
Stability	very stable throughout	unstable in lower levels	fairly stable throughout	unstable	very unstable	very unstable
Tropopause Height	very low	low	low	medium	high	Very high

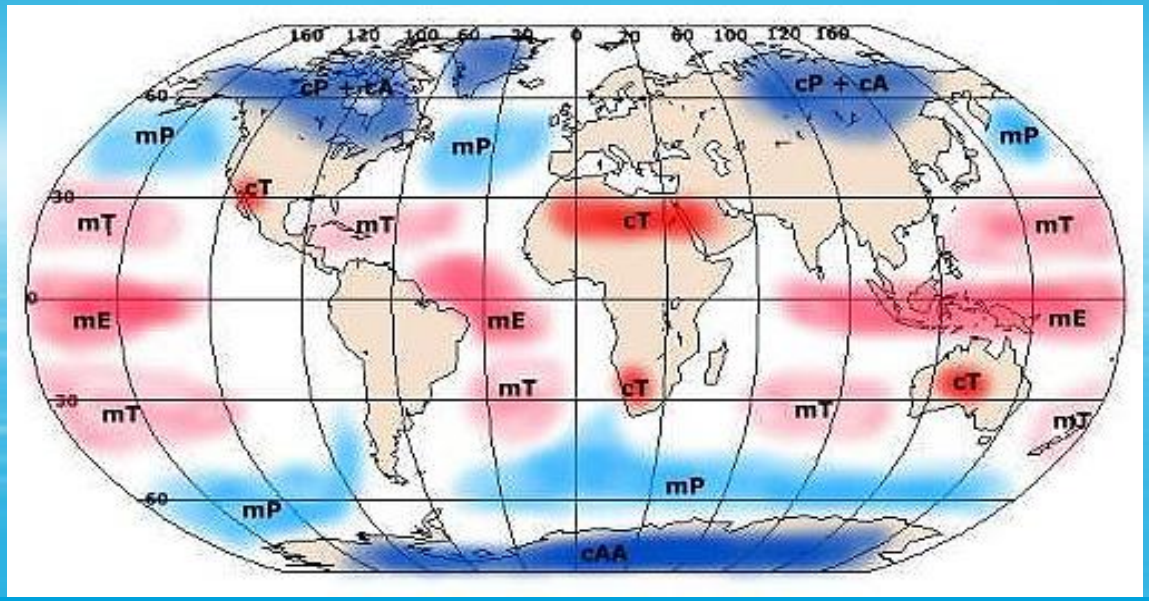
- Any combination of these air masses create distinct characteristics and climates.

Check for Understanding

- Describe the two types of air masses and their origins.
- Explain why the tropical region has little to no climate change.

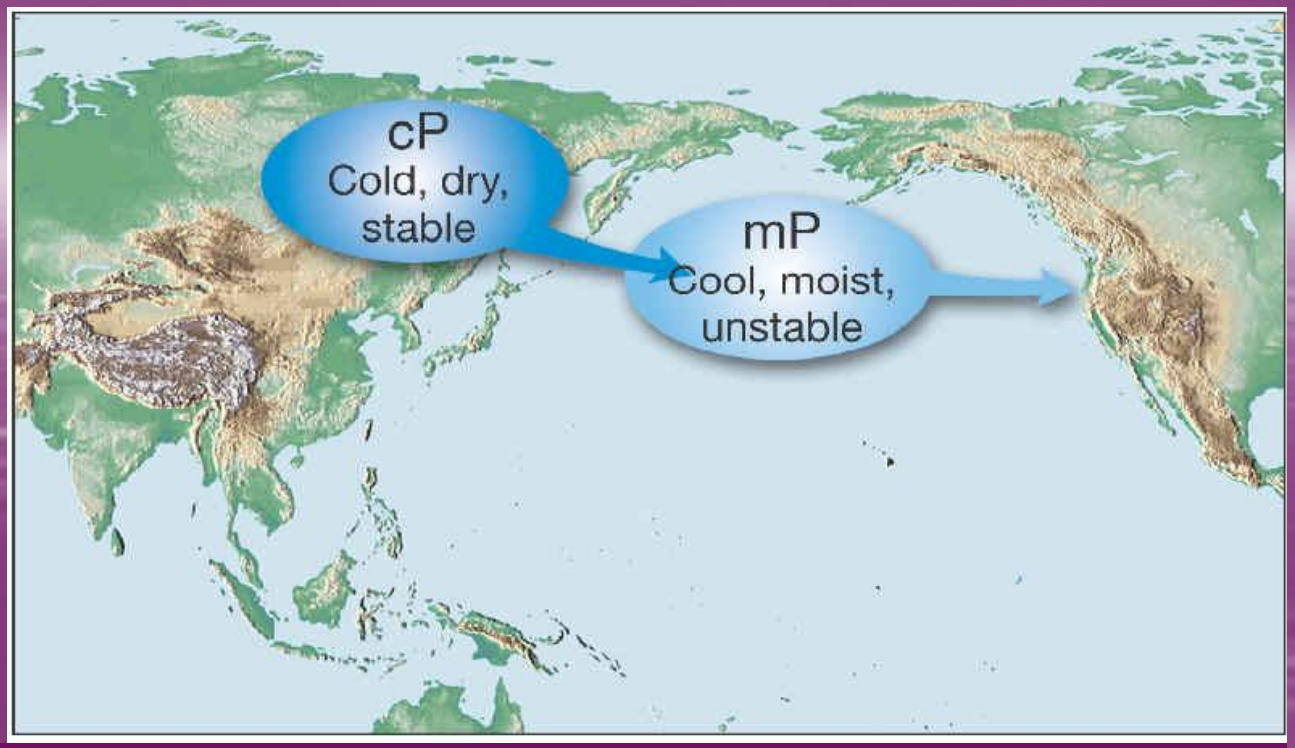
Write answers with complete sentences and in your own words.

Lesson 2- Defining Continental Air Masses



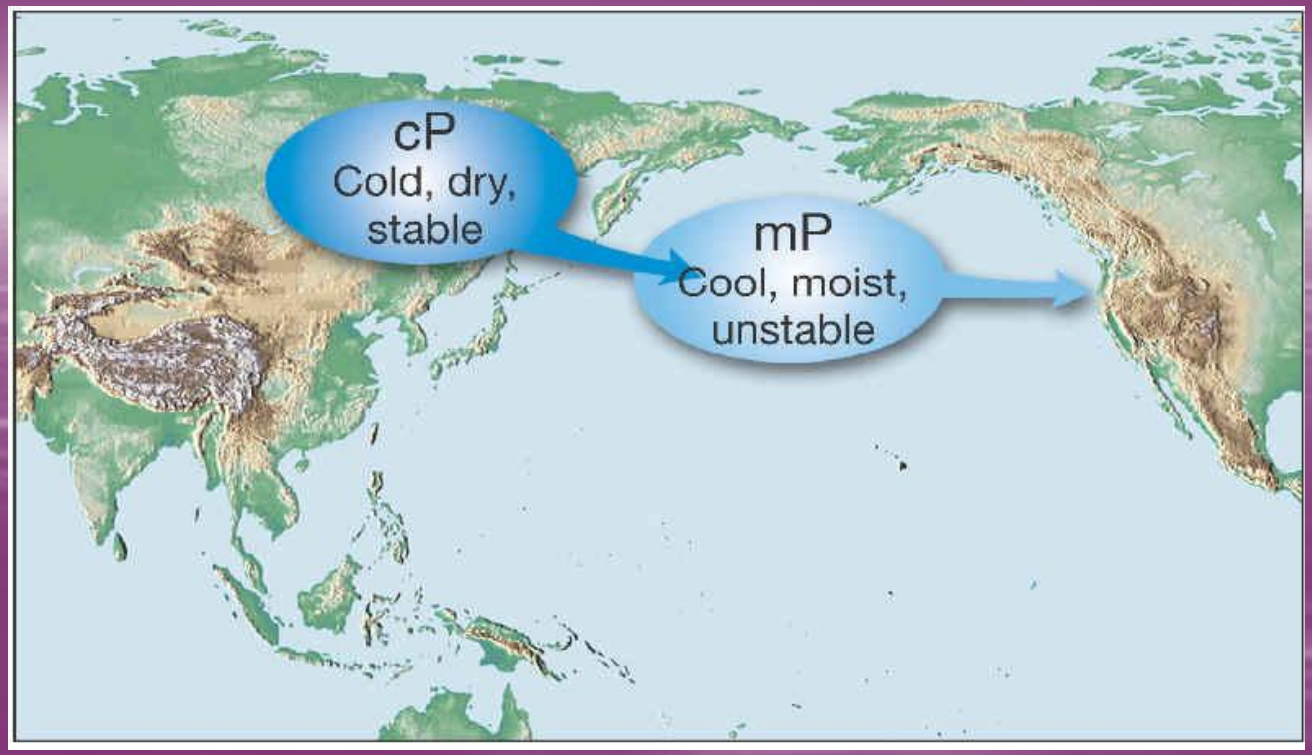
- There are two types of continental air masses: *continental polar* (cP) and *continental tropical* (cT).
- Continental polar air masses are cold and dry.
- Continental tropical air masses are warm and dry.

Maritime Air Masses



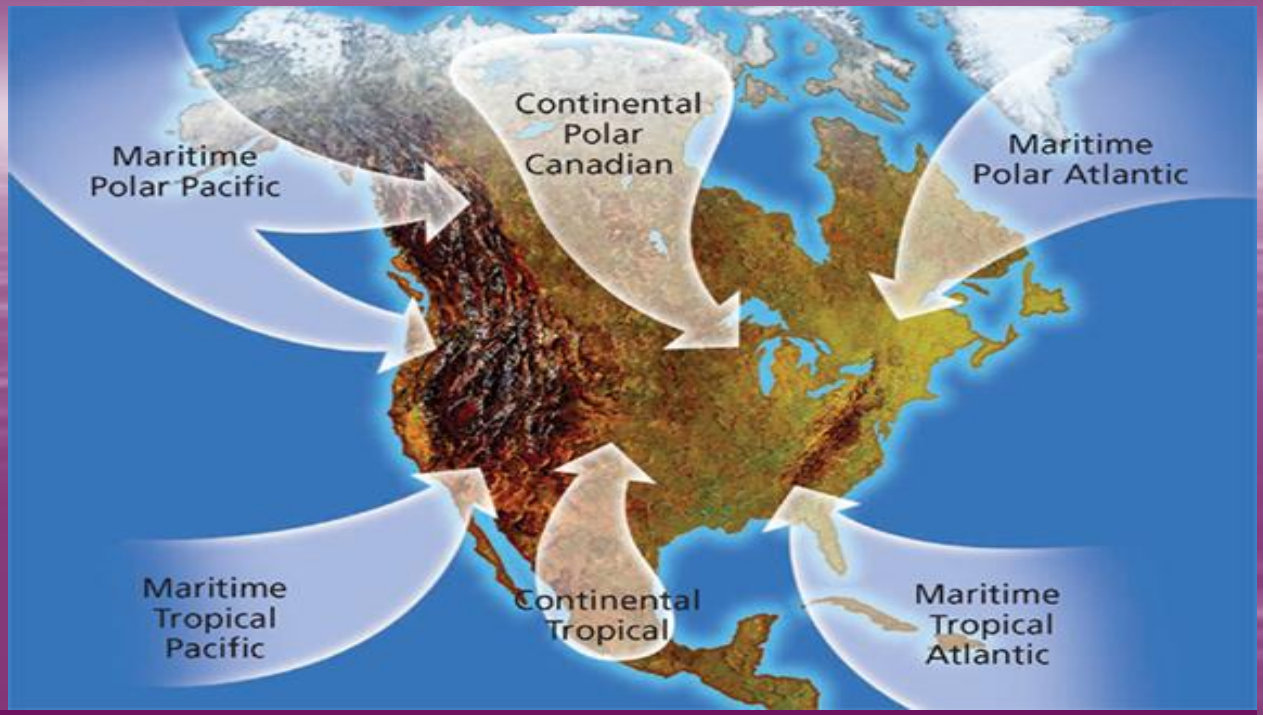
- When these very moist masses of air travel to a new location, they commonly bring more rain & fog.
- The two different maritime air masses are *maritime polar* (mP) and *maritime tropical* (mT).

Maritime Air Masses



- Maritime polar air masses are moist and cold.
- Maritime tropical air masses are moist and warm.

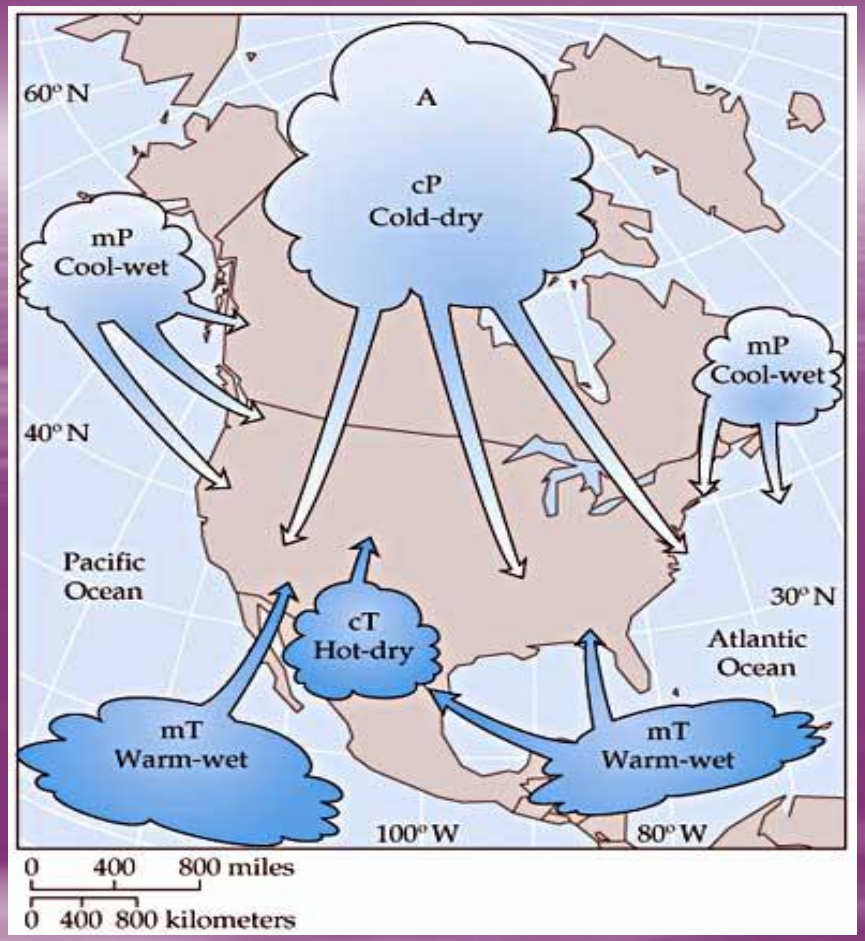
North American Air Masses



- There are four types of air masses that affect the weather of North America. It comes from six regions:
- (1) Maritime Polar
- (2) Continental Polar
- (3) Continental Tropical
- (4) Maritime Tropical.

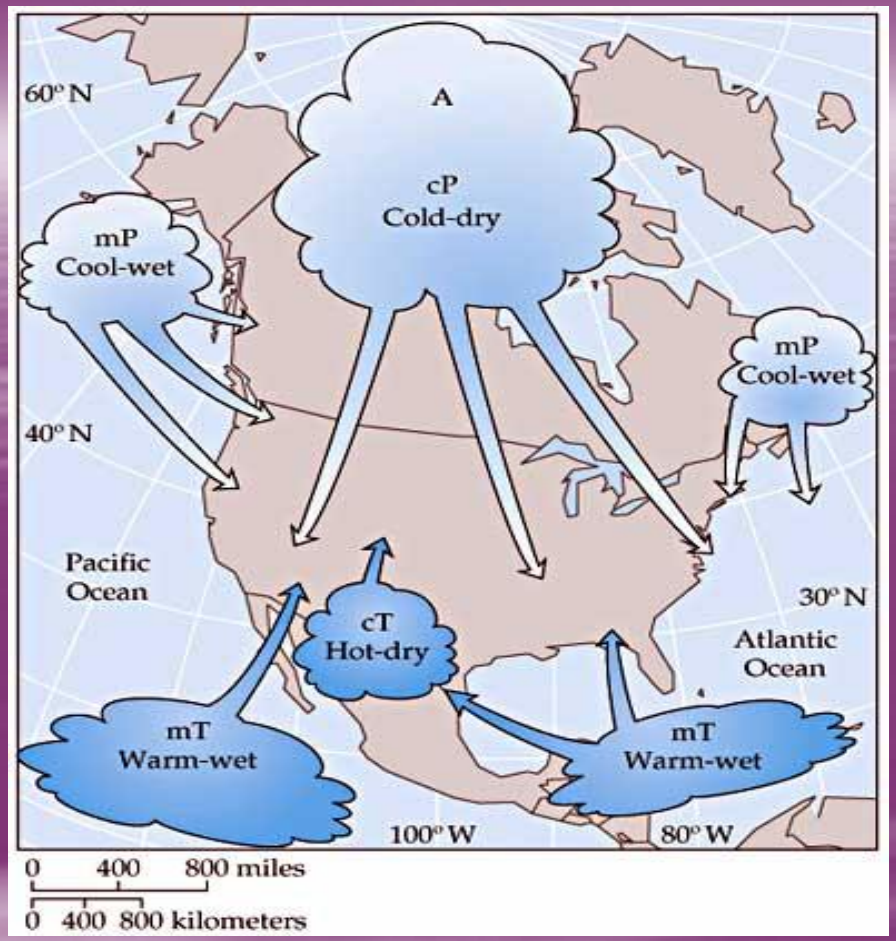
North American Air Masses

- An air mass usually brings the weather of its source region, but an air mass may change as it moves away from its source region.



- Continental tropical air masses form over the deserts of the Southwestern United States.
- These air masses bring dry, hot weather in the summer and do not form in the winter.

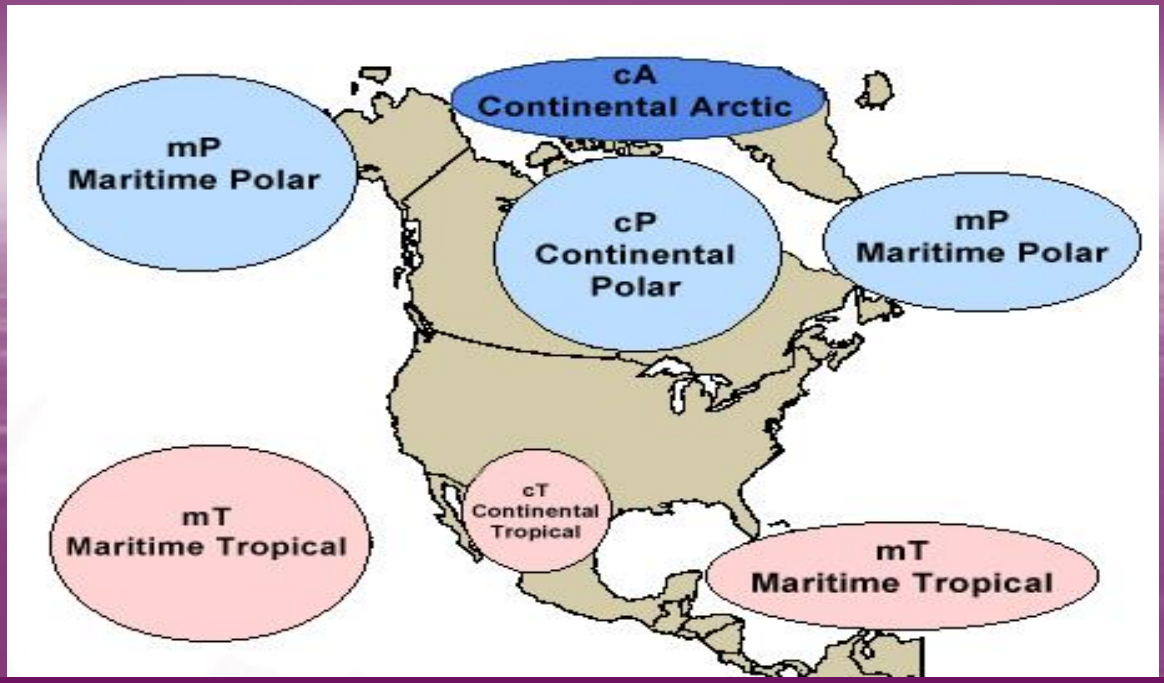
Continental Tropical and Maritime Tropical



- Maritime tropical air masses form over the warm water of the tropical Atlantic & Pacific Oceans.
- Heat and moisture are transferred to the overlying air from the waters below transporting warm moist air into the United States, increasing the potential for precipitation.

Continental Tropical and Maritime Tropical

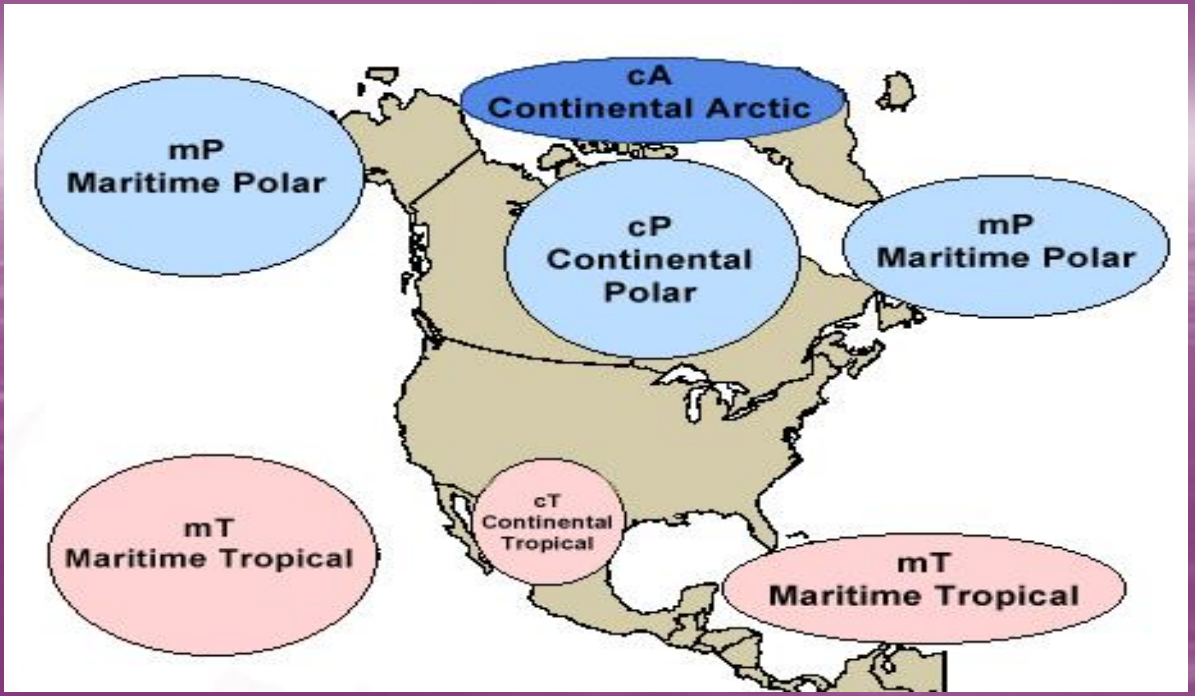
Polar Air Masses



- Polar air masses from three regions influence weather in North America.

- (1) Northern Canada
- (2) Northern Pacific
- (3) Atlantic Oceans

Polar Air Masses

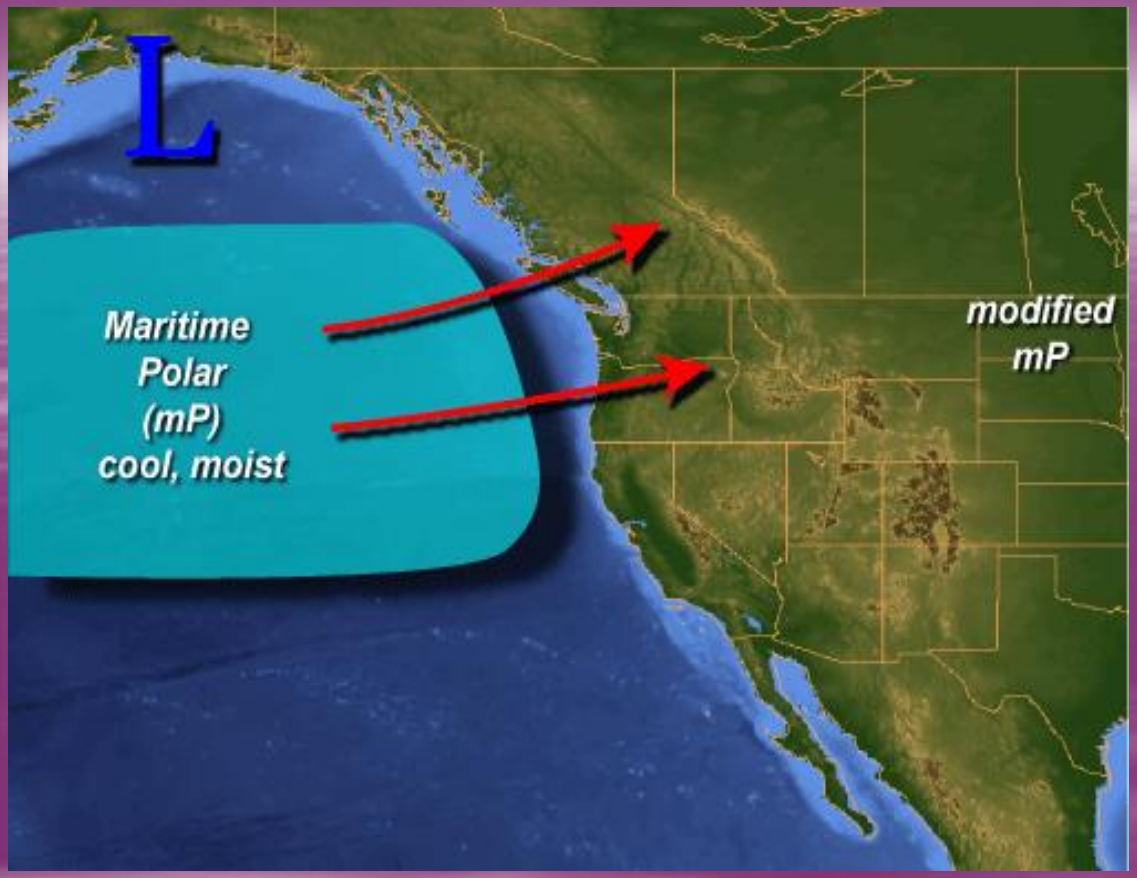


- In summer, the polar air masses usually bring cool, dry weather.
- In winter, polar air masses bring very cold weather to the northern United States.

Check for Understanding

- Predict the weather: Maritime tropical air masses form over the warm water of the tropical Atlantic & Pacific Oceans. What will the weather be as the air masses flow over the United States?

Write answers with complete sentences and in your own words.



- Maritime polar air masses forming over the North Pacific Ocean and North Atlantic are very moist, but they are not as cold as continental polar Canadian air masses.

Maritime Polar Air Masses

Chapter menu
Resources

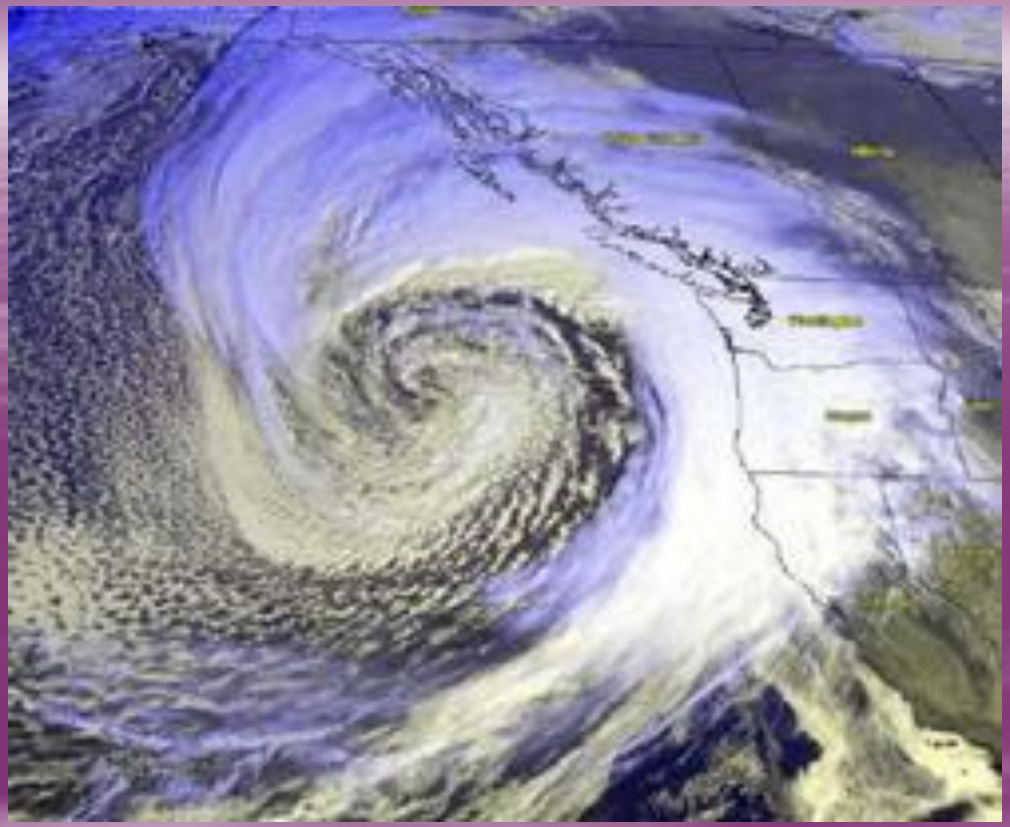
- In winter, these maritime polar air masses bring rain and snow.
- In summer, they bring cool, often foggy weather.

Maritime Polar Air Masses

Chapter menu
Resources

California

- The Maritime Polar Pacific and the Maritime Tropical are the two air masses that most often bring rain to California in the winter.



- These air masses are driven by the mid-latitudes winds of the prevailing Westerlies.
- As the air masses move over the Pacific Ocean, they absorb moisture from the evaporation of ocean water.

California

Why is there air?

Air

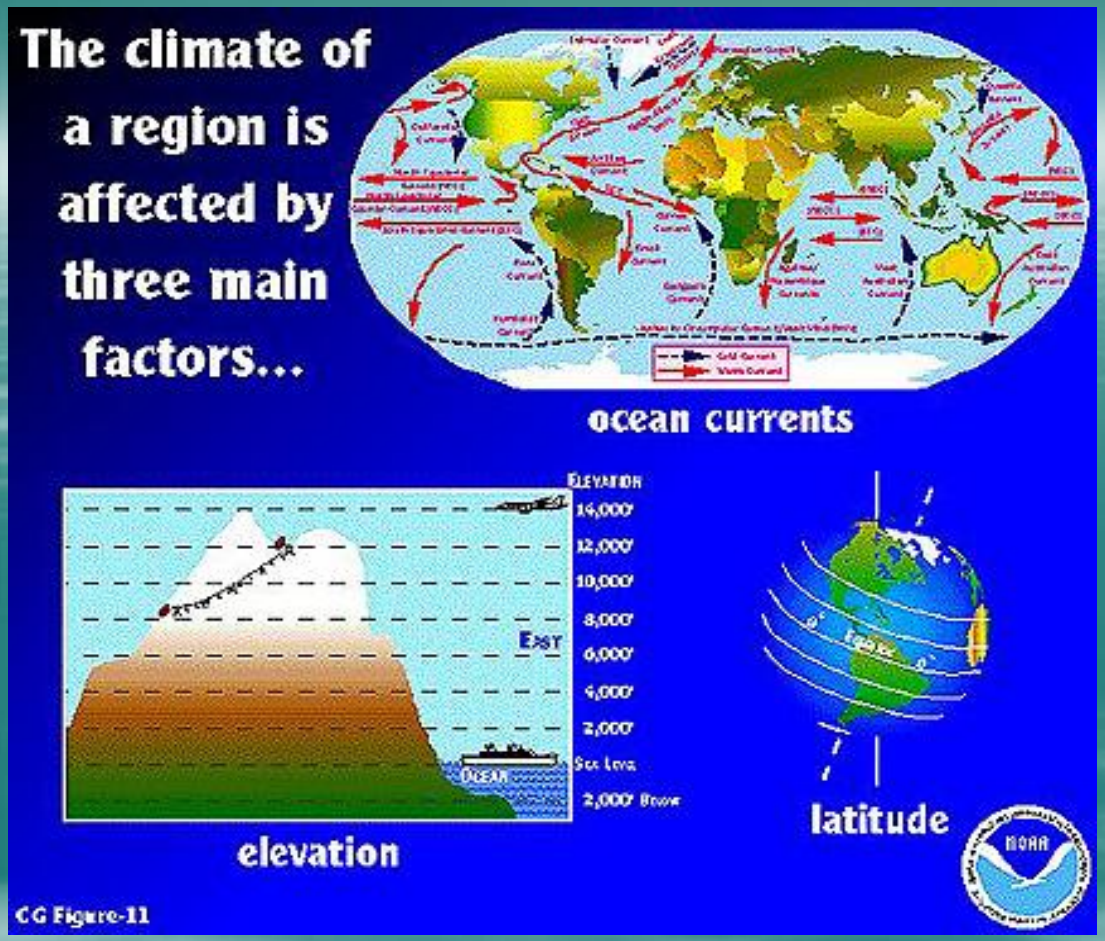
Chapter menu

Resources

Check for Understanding

- Describe the air masses that affect the California region.
- How are air masses different between continental polar and maritime polar.

Write answers with complete sentences and in your own words.

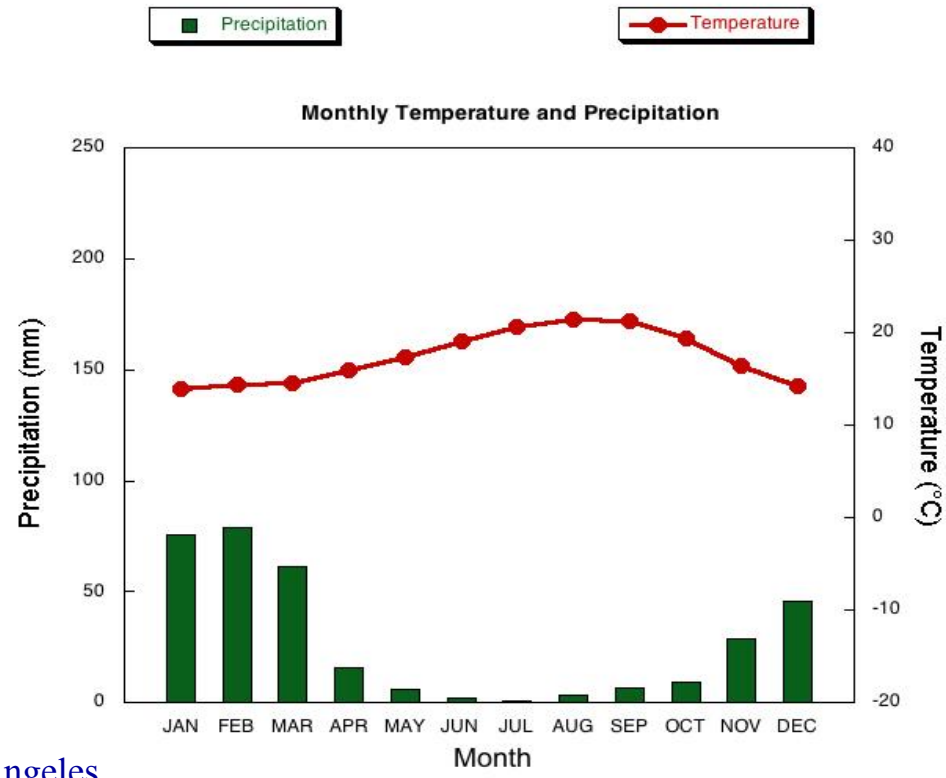


- Climate is the average weather conditions in an area over a long period of time.
- The climate of a region is affected by 4 main things:
- (1) Latitude
- (2) Elevation
- (3) Topography (Coastal vs. Inland)
- (4) Ocean Currents

Lesson 3 - (CH 25) What is Climate

Chapter 25

What is Climate

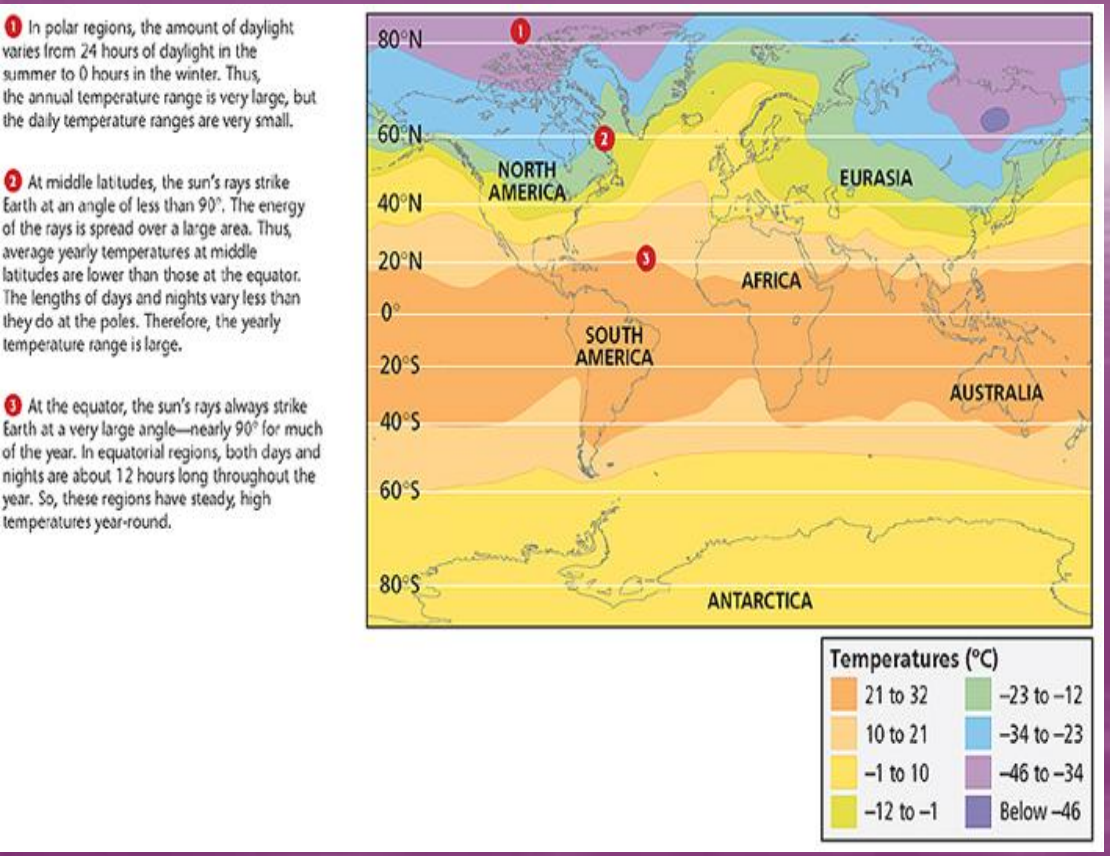


Los Angeles

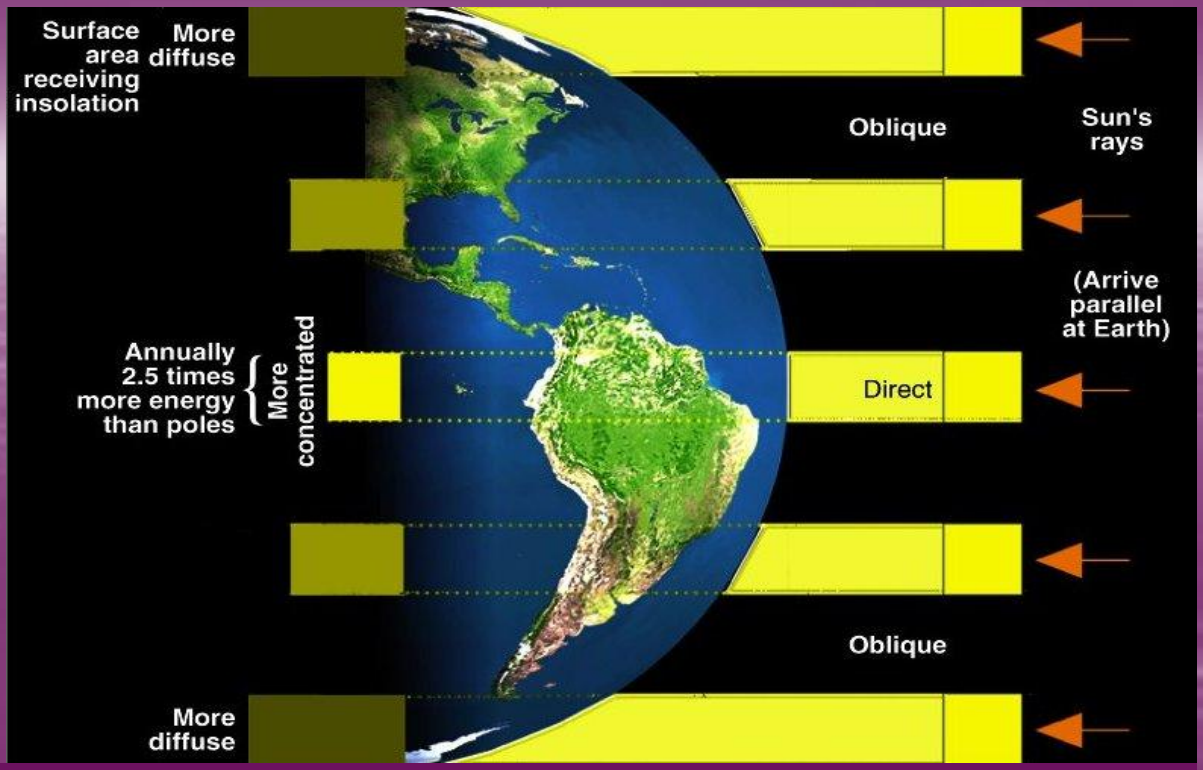
- Climates are chiefly described by using the average yearly range of temperature and precipitation.

1. Latitude as a Factor of Climate

- Your latitude on Earth determines how much solar energy is received.
- The amount of solar energy received determines the temperature and wind patterns of an area, which influence the average annual temperature and precipitation.

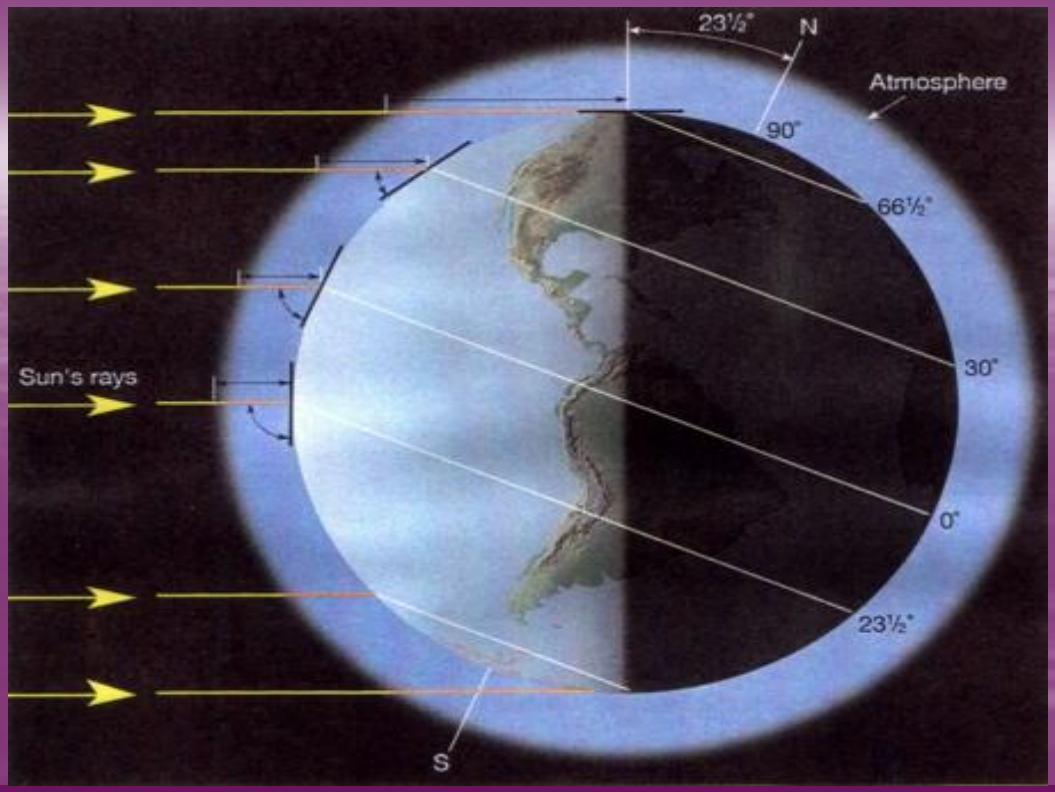


1. Latitude as a Factor of Climate



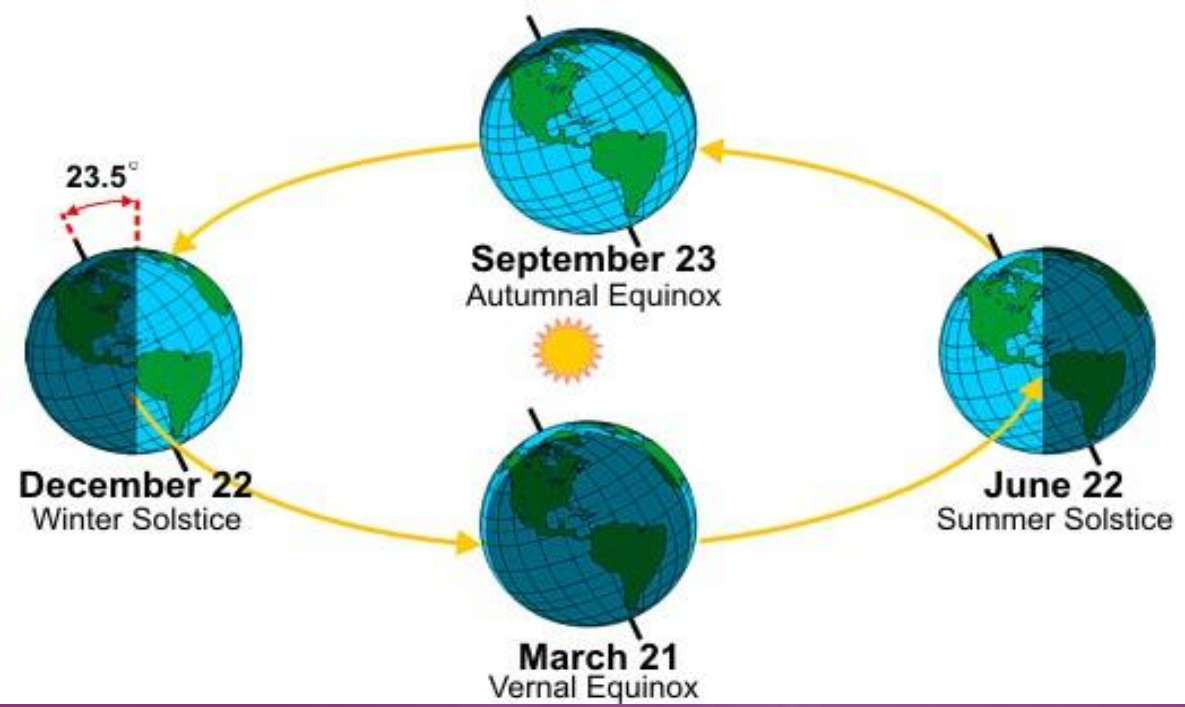
- The higher the latitude, the smaller the angle at which the sun's rays hit Earth.
- The smaller the angle, the smaller the amount of solar energy that is received by that area.

Latitude and the effects of Solar Energy



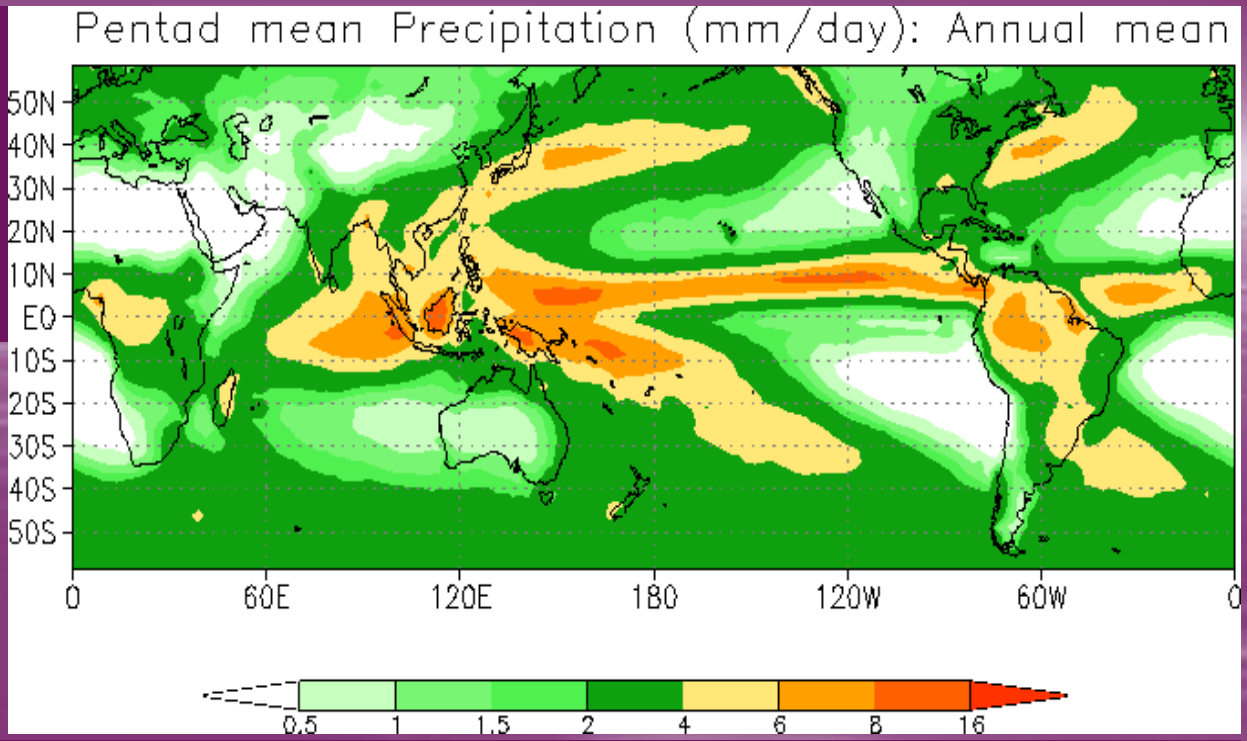
- At the equator (0° latitude) , the sun's rays hit Earth at a vertical (90°) angle.
- This results in higher temperatures at the equator then at the poles.

Latitudes and Global Wind Patterns (Doldrums/Horse Latitudes)

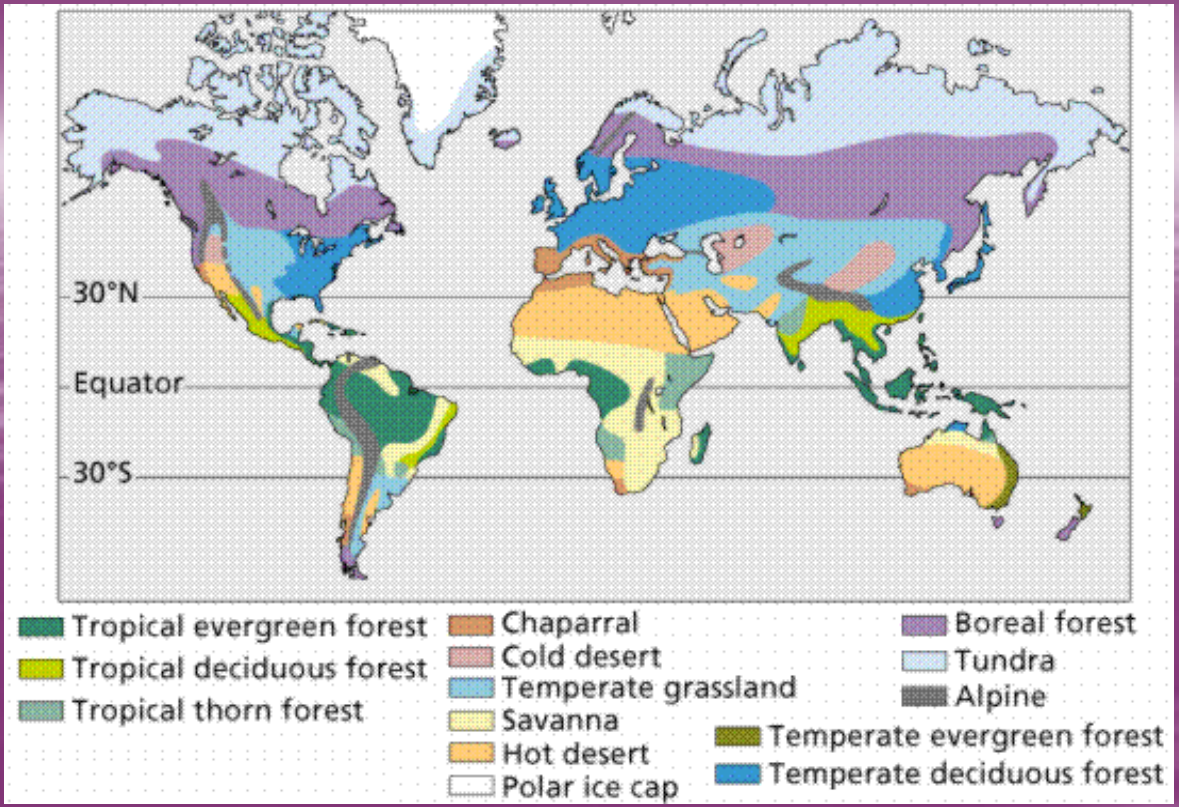


- Because Earth receives different amounts of solar energy at different latitudes, latitude has a major affect on yearly averages of local temperatures.

Equatorial Precipitation Patterns



- Another affect of latitude are the local winds or lack of.
- In the equatorial belt of low pressure, called the doldrums, high rates of evaporation equal large amounts of precipitation (All rain forests are located at this latitude).

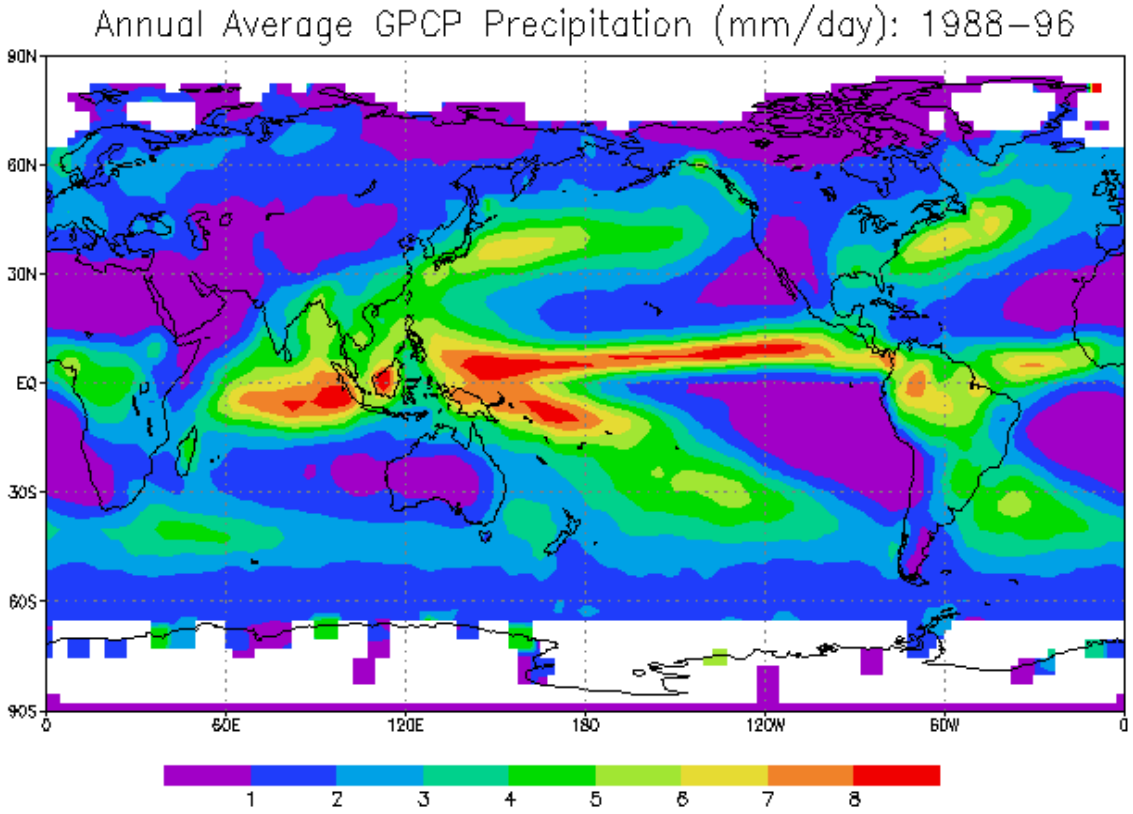


- Between 20° and 30° latitude there are subtropical highs also known as the horse latitudes.

Horse Latitudes

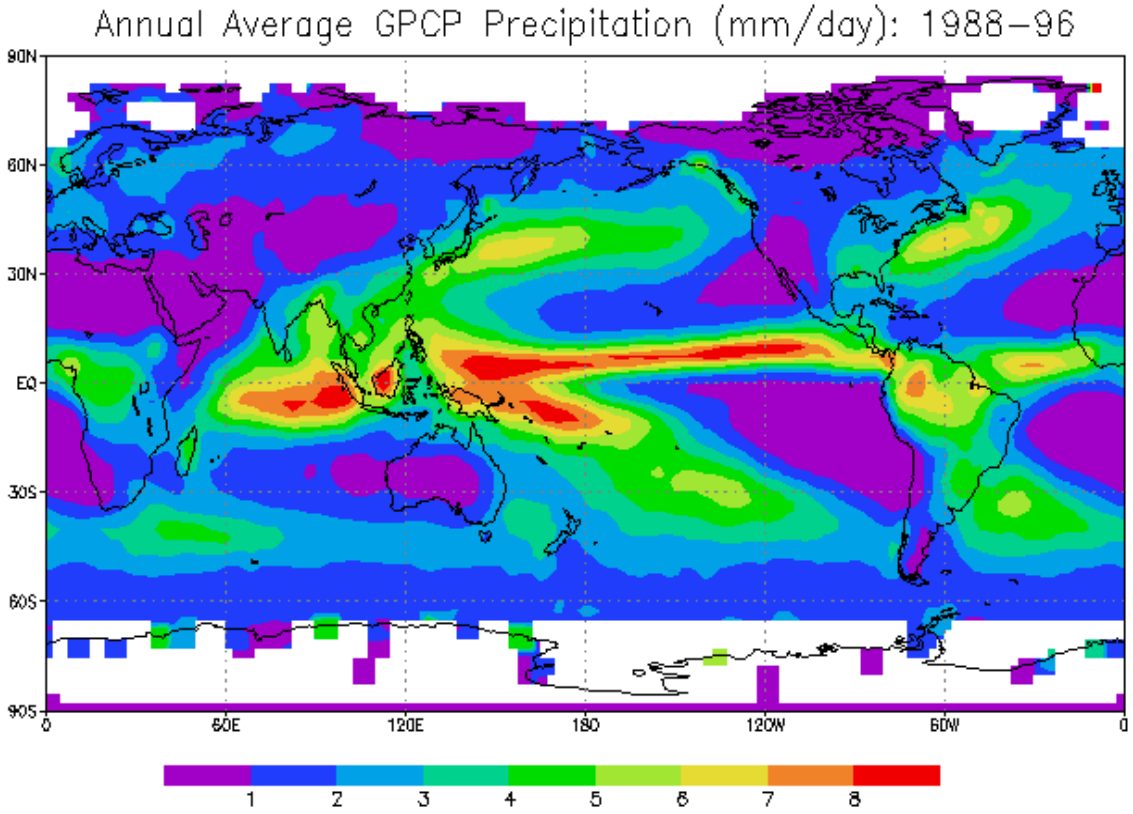
- Because air sinks and dries very little rain occurs in these regions (Most deserts are located here).

Horse Latitudes



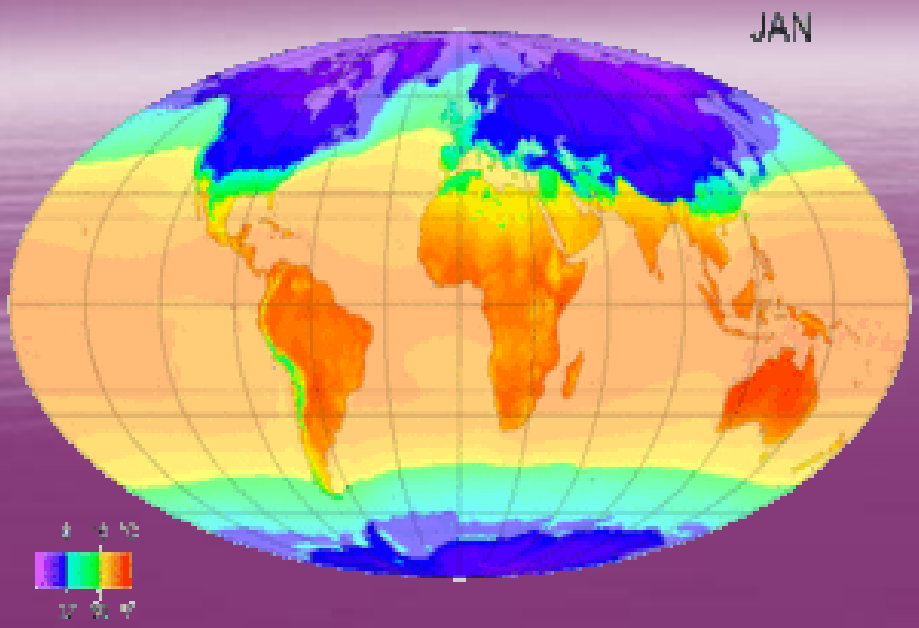
- Between 45° and 60° latitude warm tropical air meets cold polar air, which leads to belts of greater precipitation.

Mid-latitude Precipitation Patterns



- Above 60° latitude the high pressure areas create air masses that are cold and dry, which equals low average precipitation.

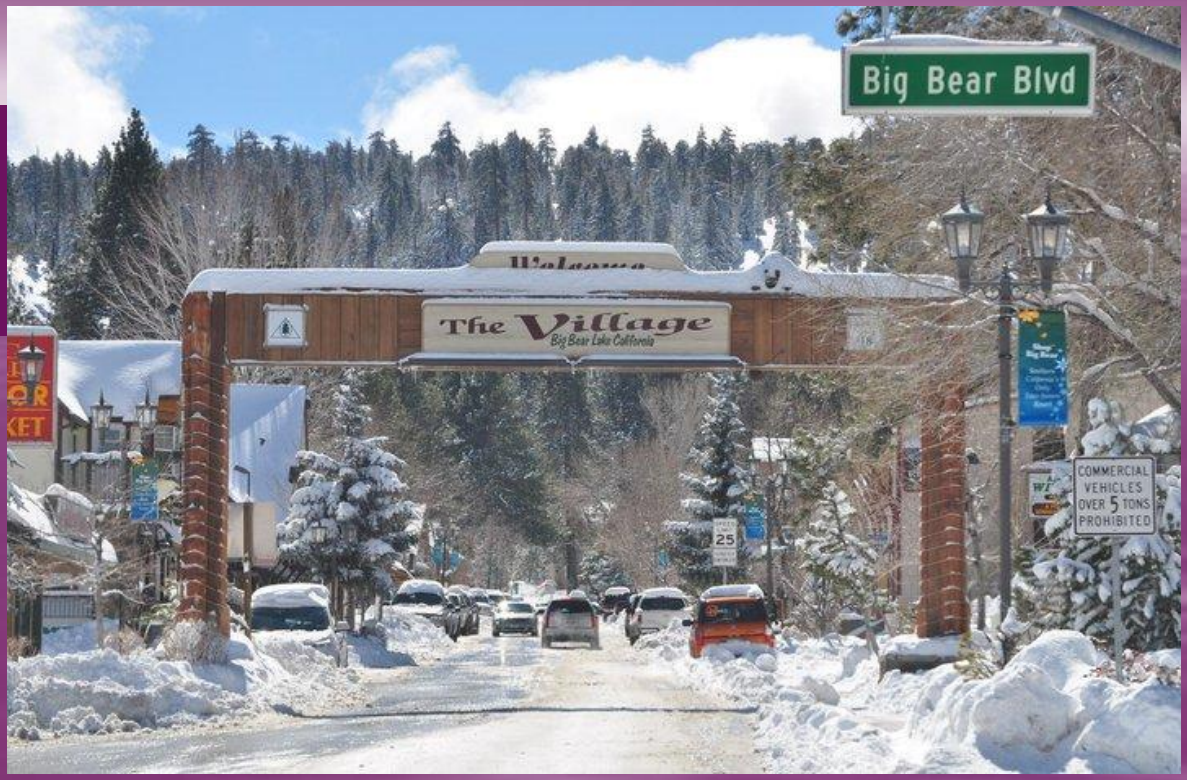
Mid-latitude Precipitation Patterns



- As seasons change, the global wind belts shift in a north or south direction.
- As the wind and pressure belts shift, the belts of precipitation associated with them also shift.

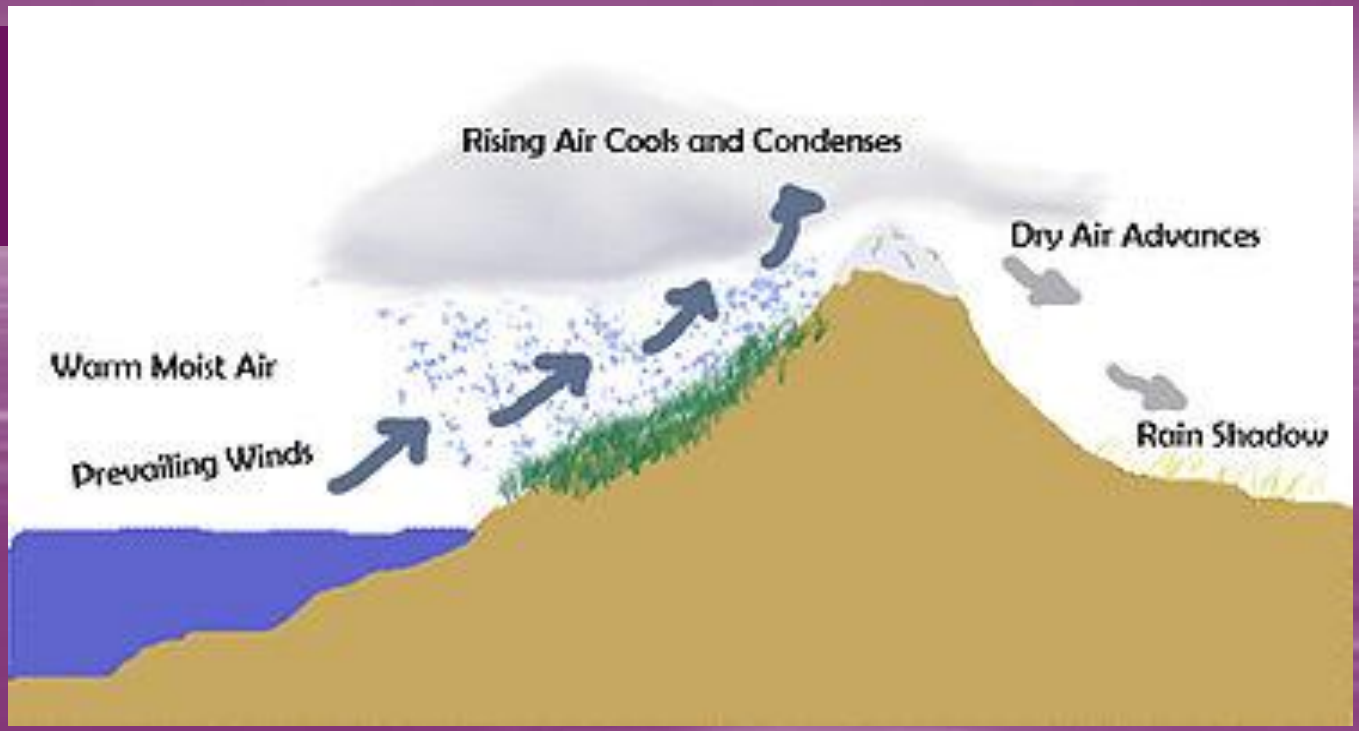
Global Wind Belt Shift

2. Elevation



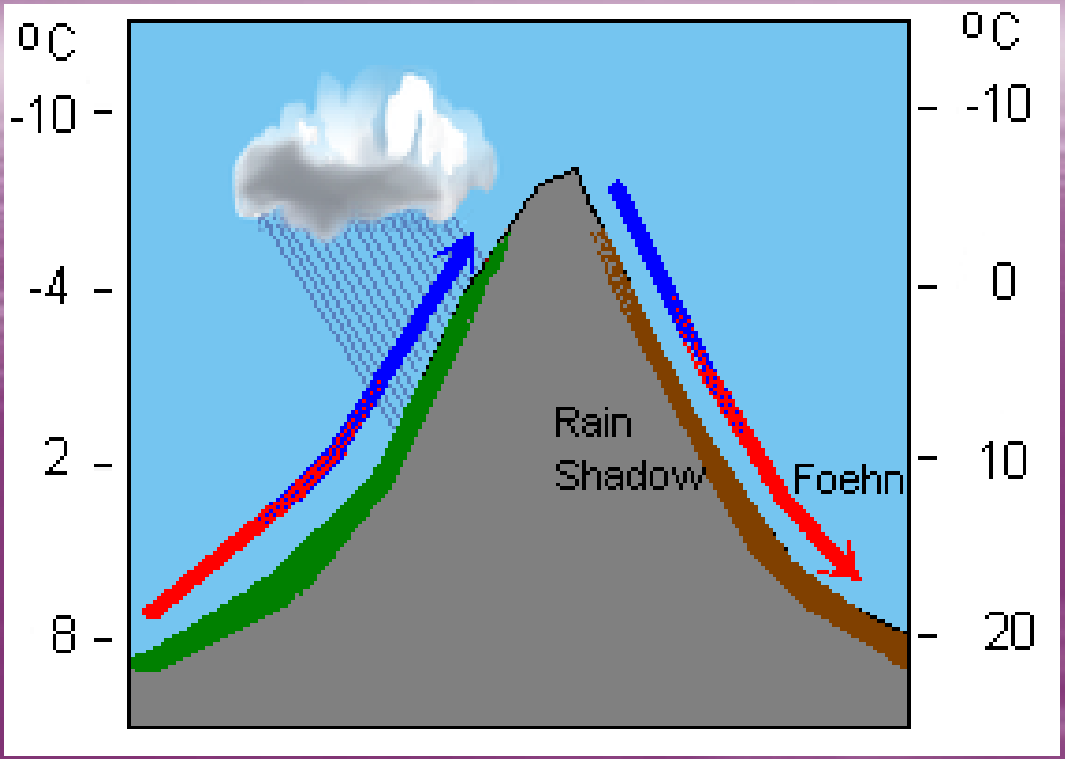
- The surface features of the land, or topography, also influences climate.
- The height of landforms above sea level, produces distinct temperature changes.

Rain Shadows



- One example of topography having an effect on climate is the rain shadow.

Chapter menu
Resources

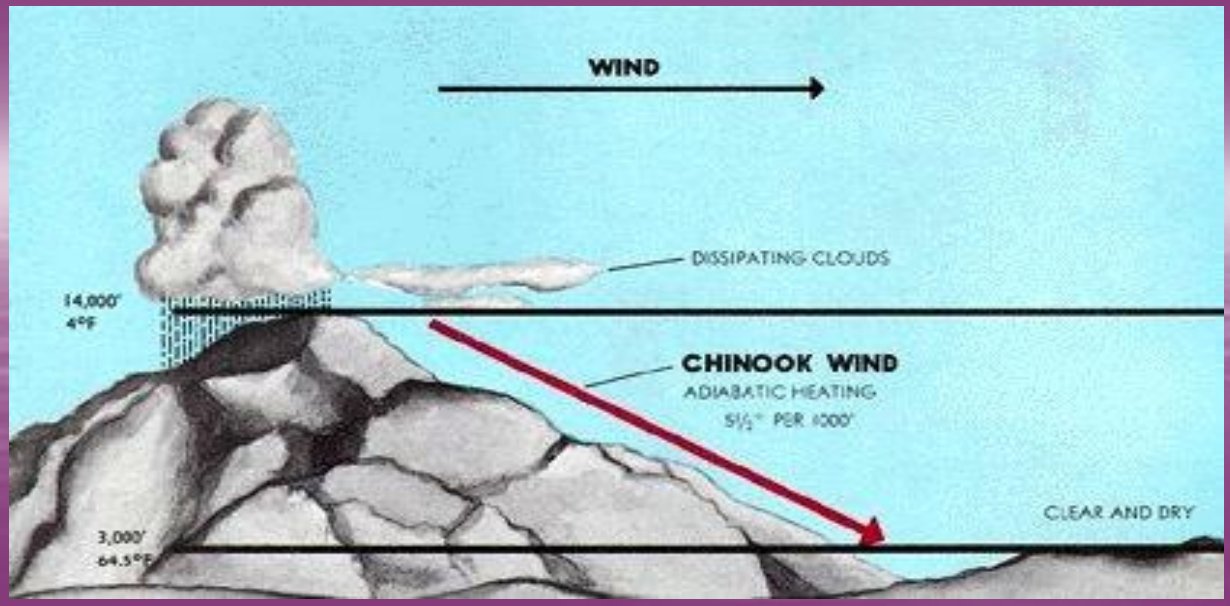


- The downward flow of dry, warm air that is part of a rain shadow is known as a foehn wind.

Rain Shadows

Chapter menu
Resources

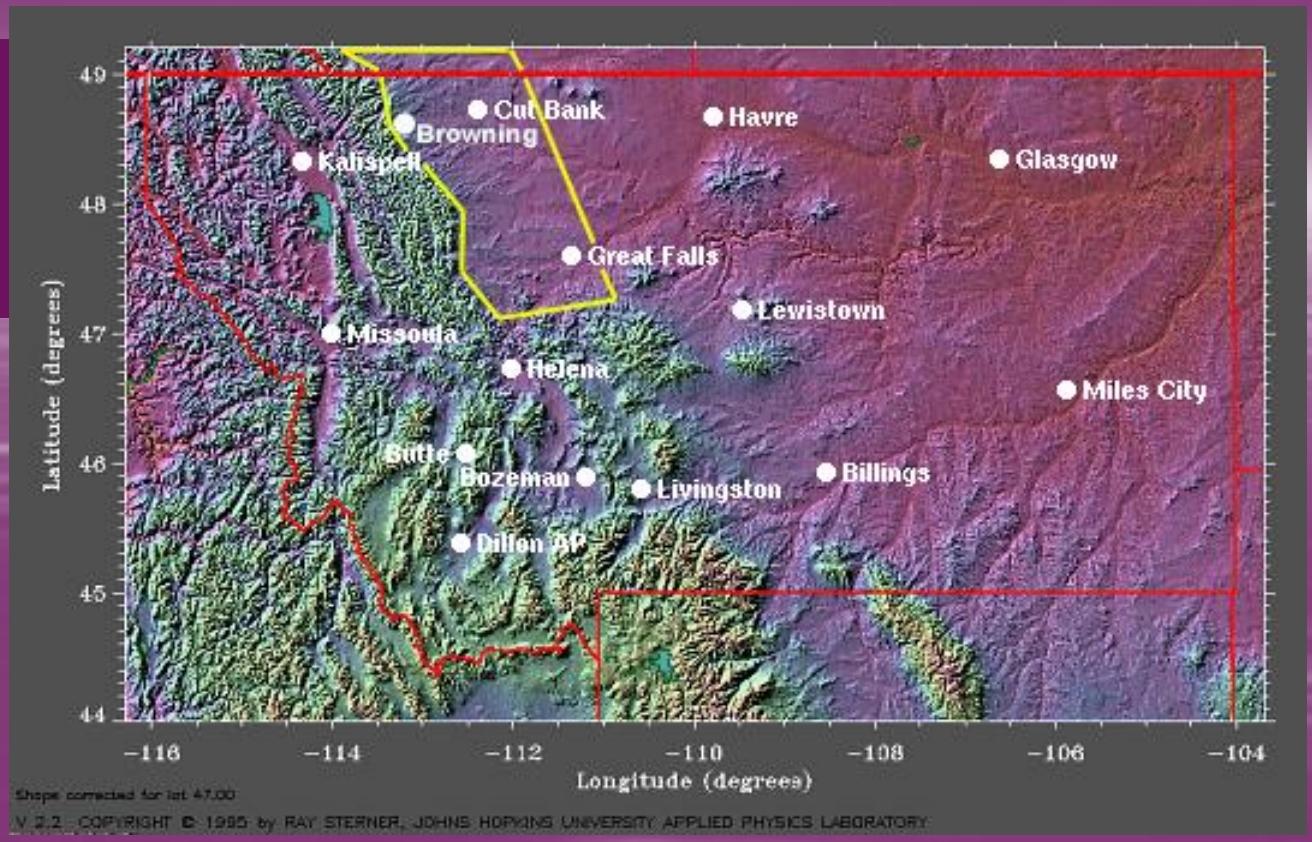
Chinook Winds



- An example of this in North America is the Chinook winds, located where the Canadian Prairies and Great Plains meet the Canadian Rocky Mountains.
- Most common in southern Alberta, Canada these winds can make snow one foot deep almost vanish in one day.

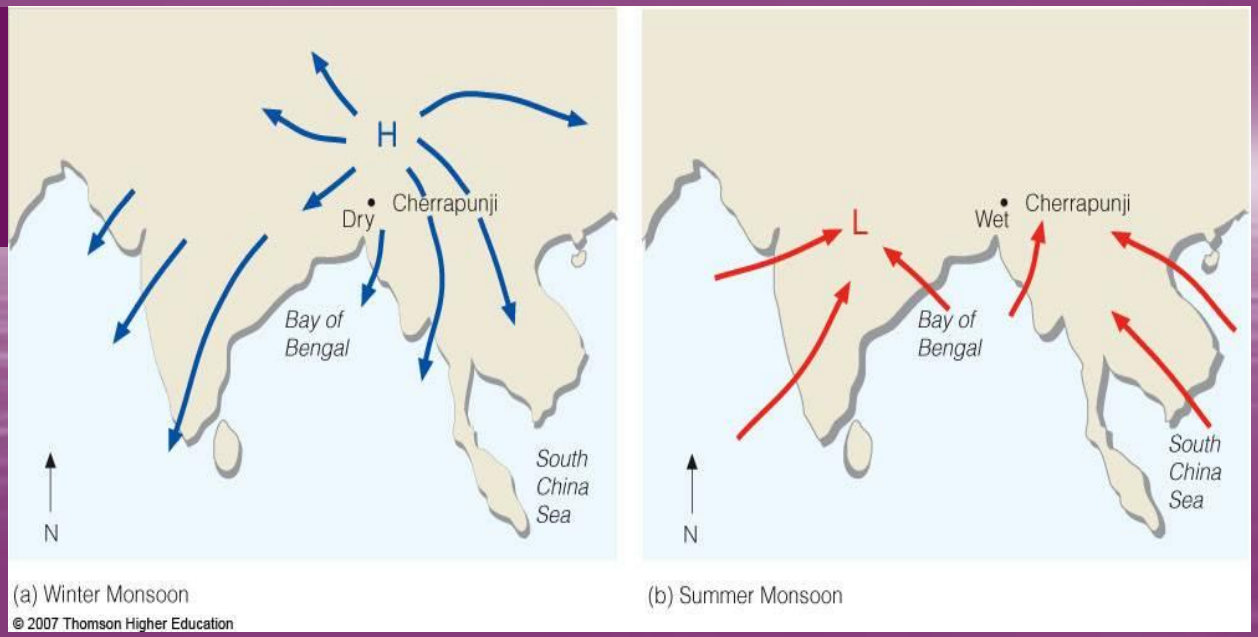
Chapter menu
Resources
End Of Slide

Chinook Winds



- Chinook winds have the record for greatest temperature change in 24 hours of 104°F (1/15/72, in Loma, Montana the temp rose from -56°F to 49°F.)

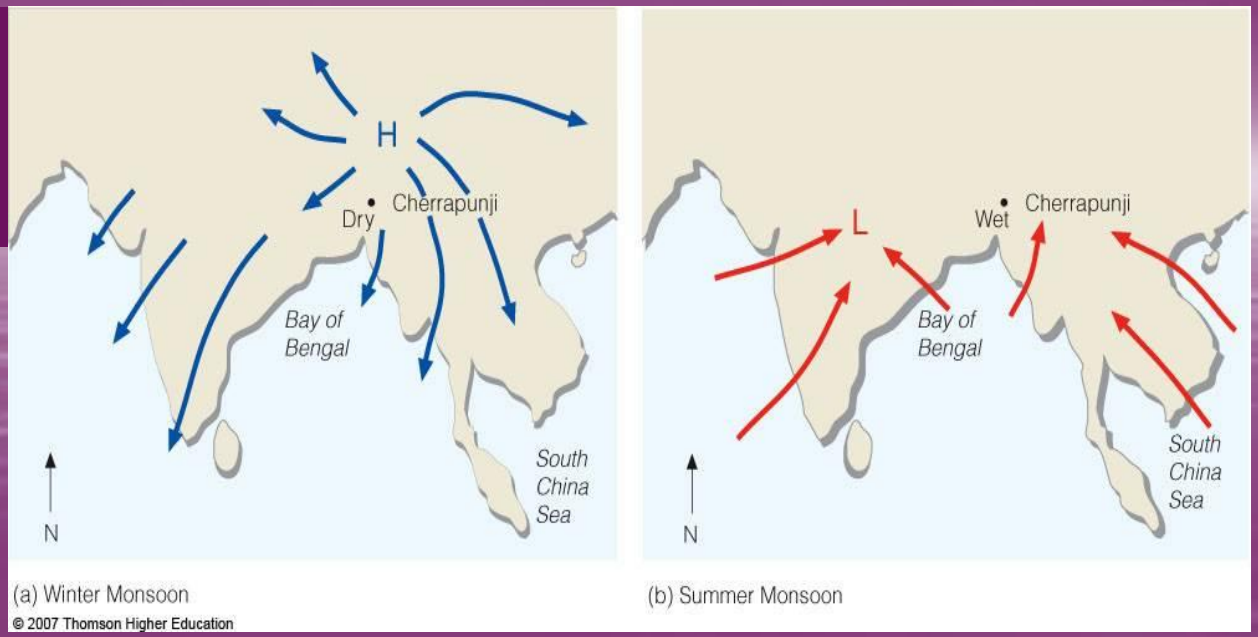
Winter Indian Monsoons



- Usually, the term monsoon is used to refer to the rainy phase of a seasonally-changing pattern, although technically there is also a dry phase.
- The major monsoon systems of the world consist of the West African and Asia-Australian monsoons.

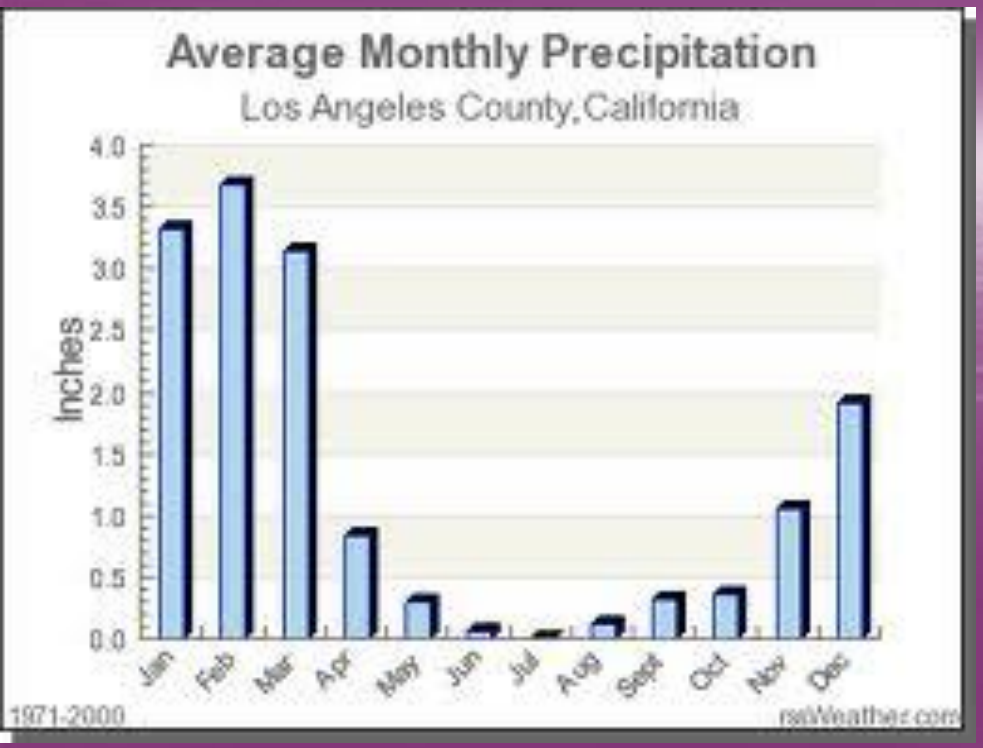
Chapter menu
Resources

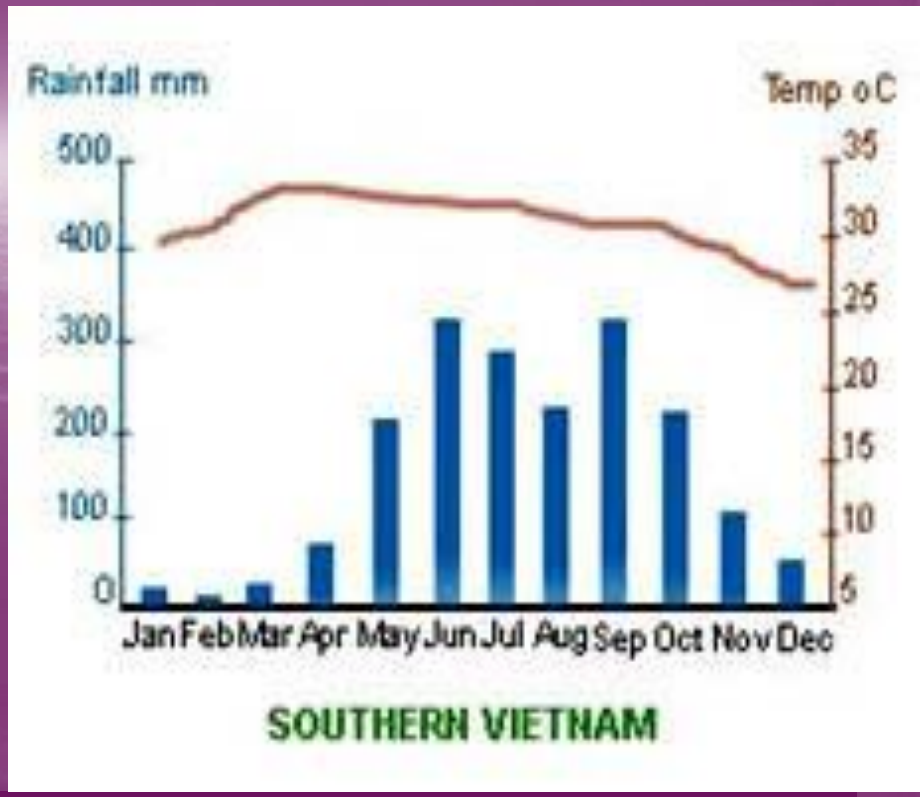
Winter Indian Monsoons



- In southern Asia the "Dry Phase" is at the beginning of winter, the subcontinent cools rapidly, while the Indian Ocean is still warm.
- The warm water heats the air over the oceans, forcing the air to rise and drawing cool air from the Himalayas bringing cool and dry weather to India during the winter.

Chapter menu
Resources





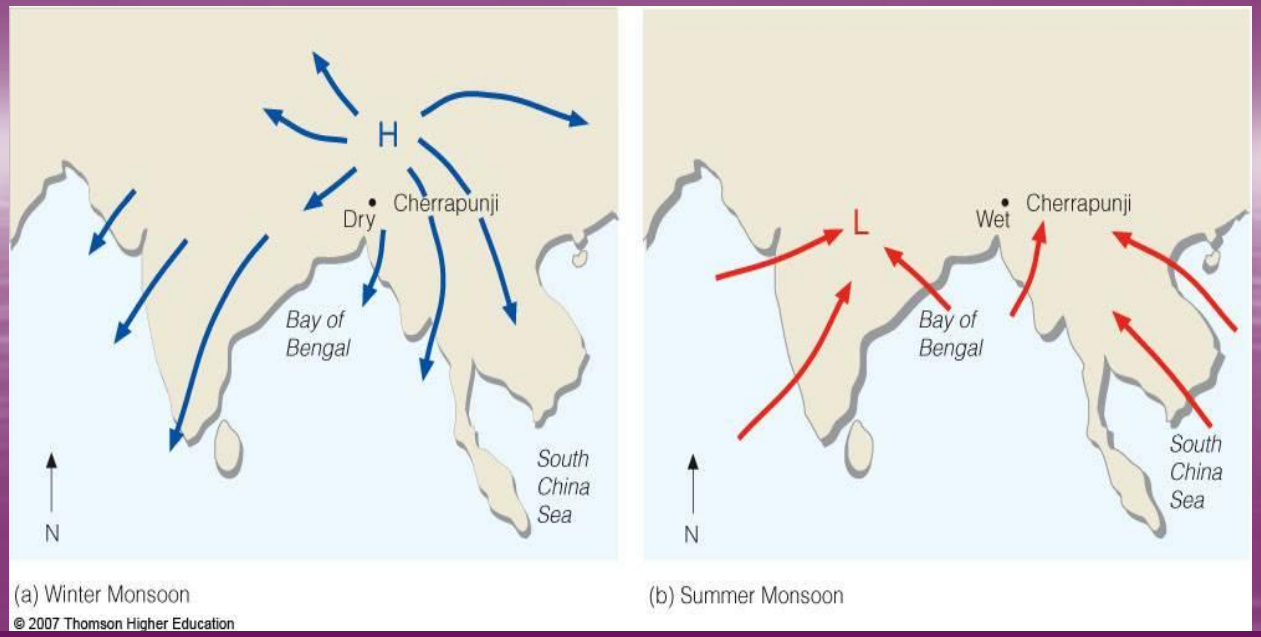
Los Angeles vs. Southern Vietnam

- In September rainfall ~ 12 inch rain & average high temp of 86° F.

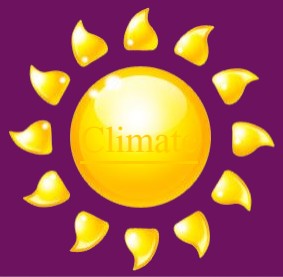
Summer Indian Monsoons

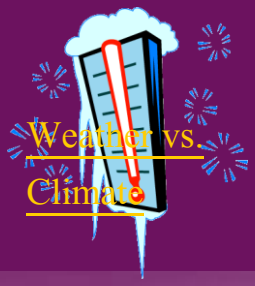
Chapter menu
Resources

Summer Indian Monsoons



- The “Rainy Phase” begins in the Summer, temperatures rise faster on land than the Indian Ocean.
- Hot air rises over the land, drawing masses of cool, damp air from the ocean towards the land, resulting in sustained, heavy rains, which normally begin in June and last until September.





Check for Understanding

1. What are the four main factors that affect climate?
2. Why would a large body of water affect climate?

Lesson 4 – How Topography Effects Climate (Coastal vs. Inland)

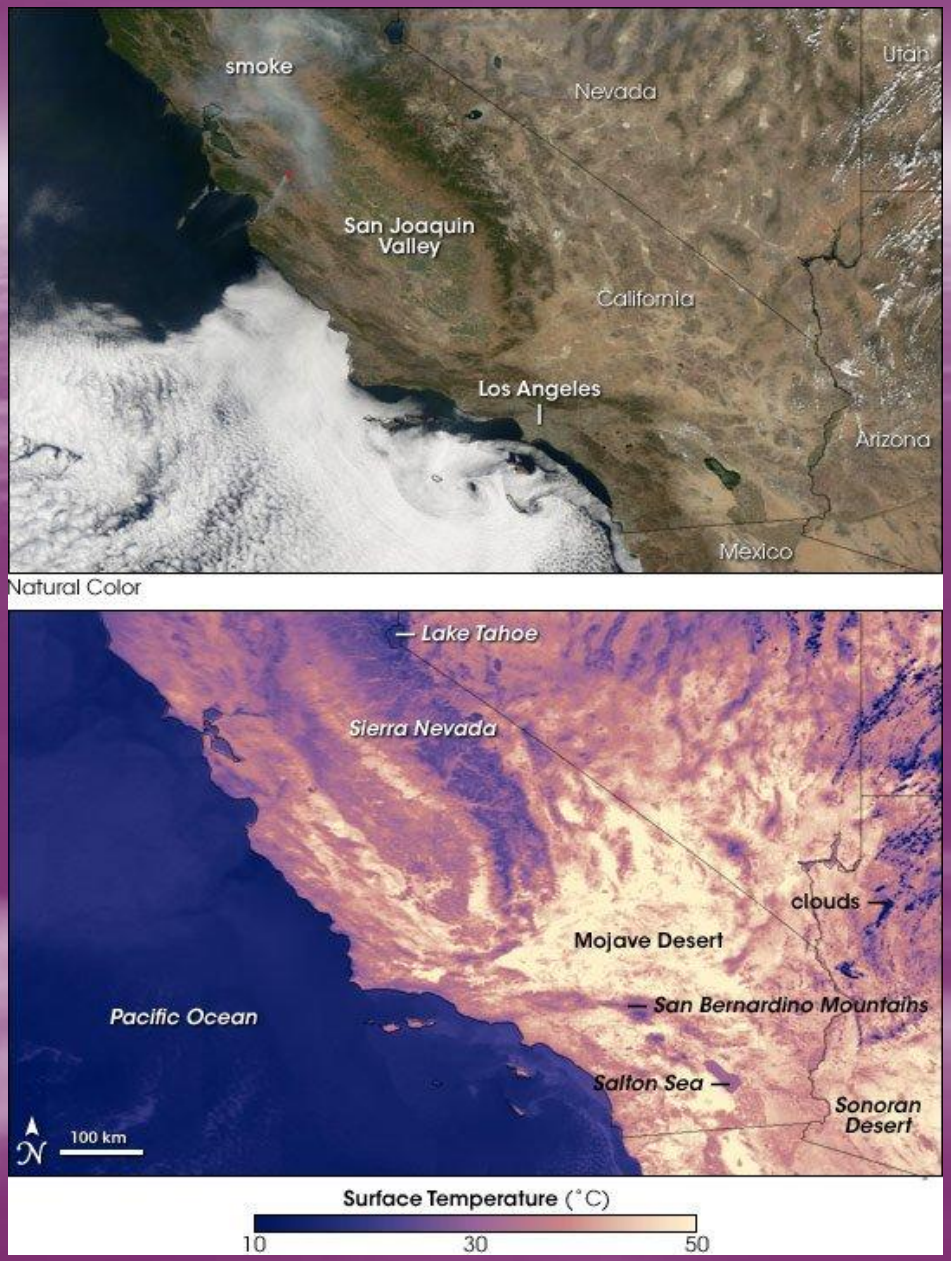
Video El Nino

- Land (Solid) heats faster than water and thus can reach higher temperatures in the same amount of time.

Chapter menu Resources

- Locations near the center of a large landmass tend to have wide ranges in temperature, both between day and night and seasonally.

How Land Effects Climate



- Heated land can also have an influence on the air above.
- An example of this is a week-long heat wave in L.A. ’07, when a high-pressure system blocked cool air from the Pacific.

How Land Effects Climate

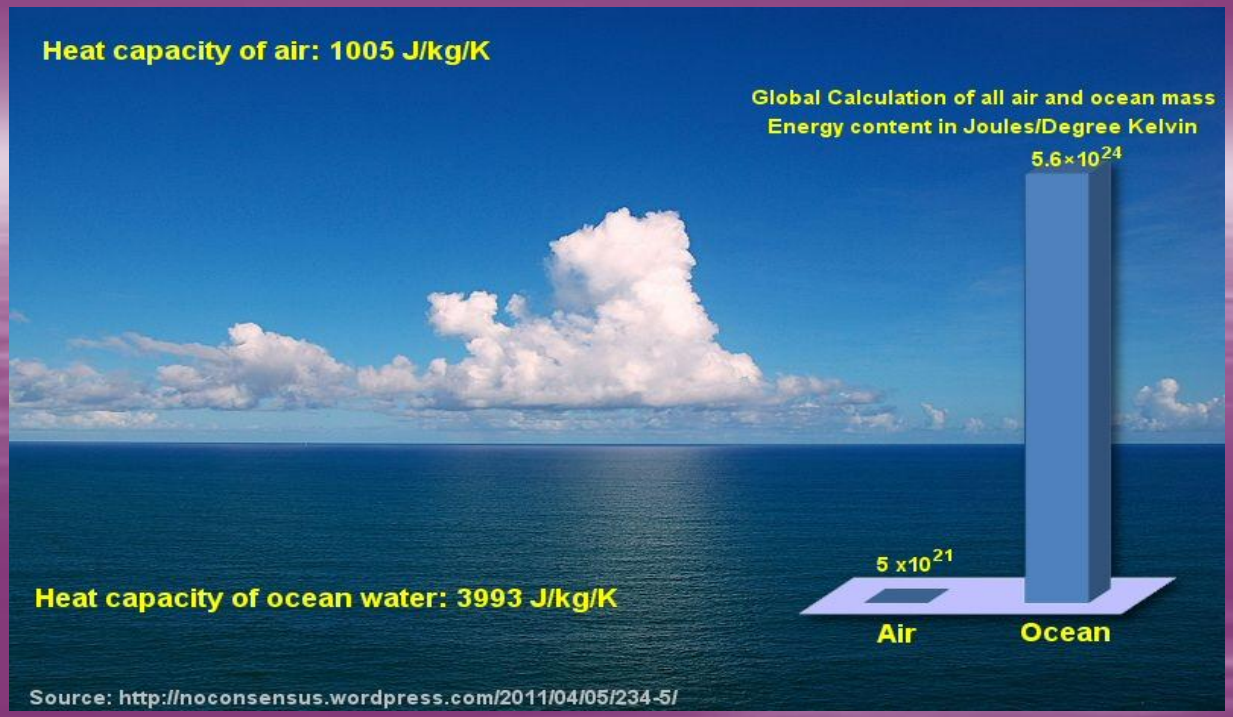
How A Body of Water Effects Climate

- Large bodies of water have a moderating effect on the temperatures of coastal areas, producing low ranges in temperature, both between day and night and seasonally.

How is Land and Water Different?

- Physicists use specific heat and heat capacity to measure the amount of thermal energy that is needed to change the temperature of objects.
- The heat capacity is a function of both the type and amount of material.

How is Land and Water Different in the Summer?



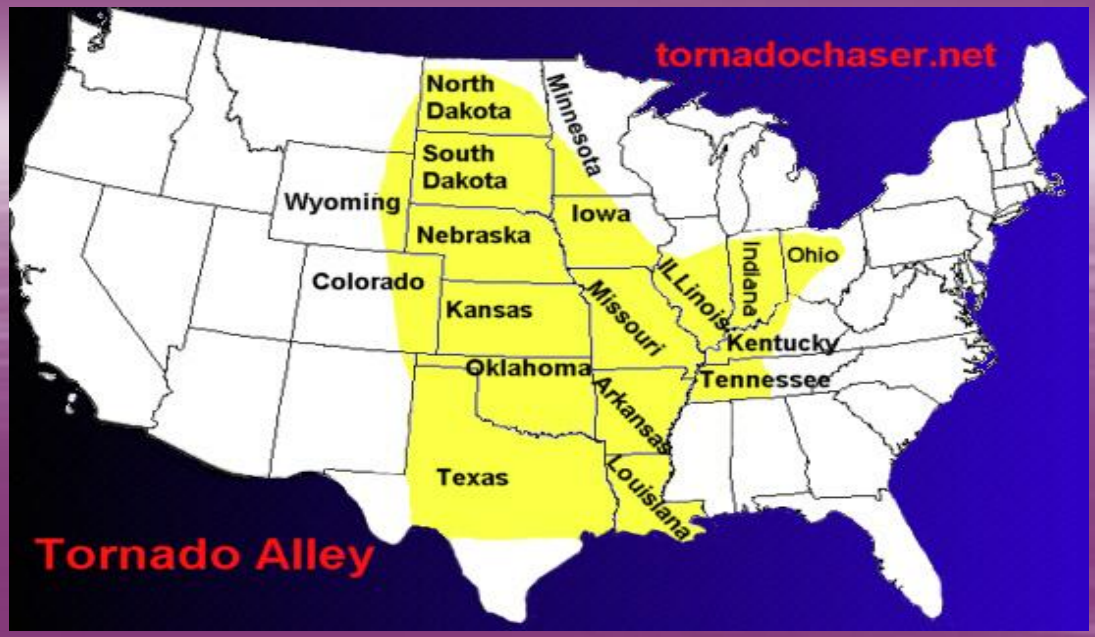
- In the summertime solar energy warms matter up.
- If you were to compare land to water (Oceans or lakes) - water needs roughly four times as much solar energy to raise the temperature versus land.

Example – Swimming Pools in June

Chapter menu

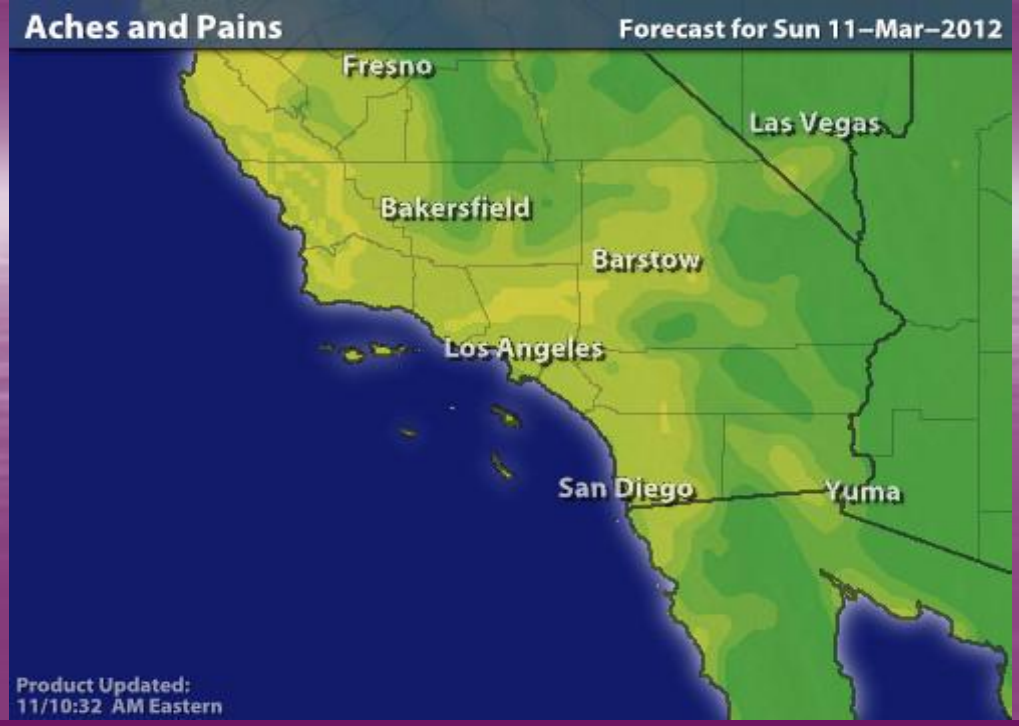
Resources

How is Land and Water Different in the Summer?



- It takes much more solar energy to warm coastal areas than to warm inland areas.
- Compare areas along the same latitude: for example Kansas to San Francisco, you would find the inland areas get much hotter in summer than the Atlantic or Pacific coastal areas of the same latitude.

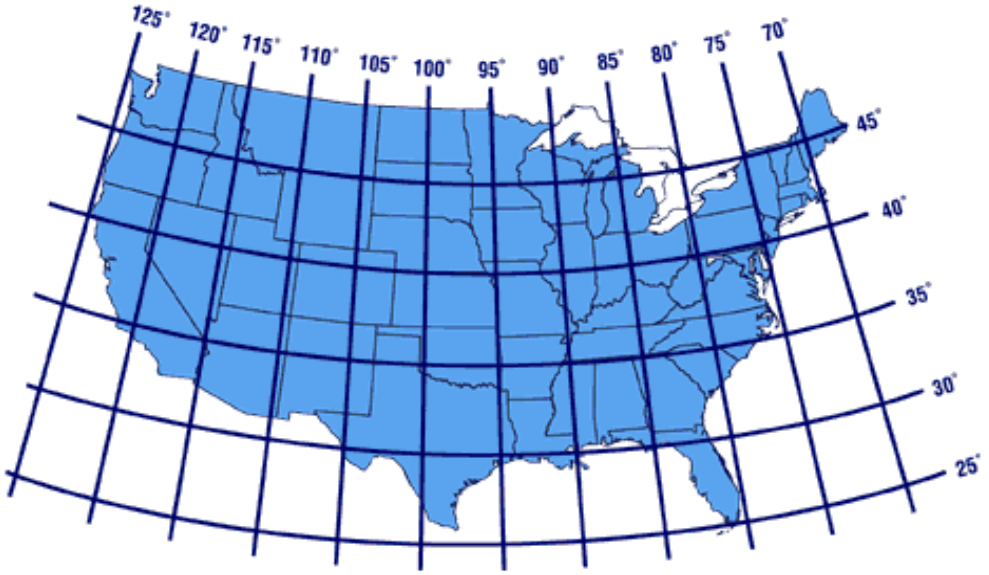
How is Land and Water Different in the Winter?



- In the cold parts of the winter, there is less warming solar energy, so the land stays cool.
- Water, in order to lower its temperature, release more heat energy into their environment than land masses do, therefore coastal areas to not get as cold as inland areas.

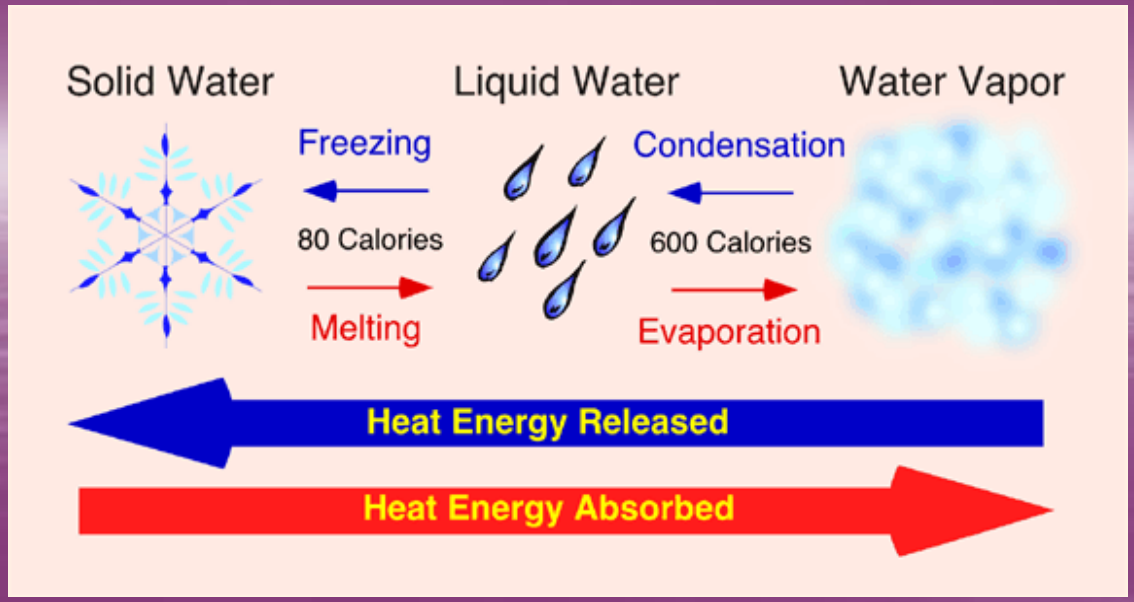
Chapter menu
Resources

How is Land and Water Different in the Winter?



- For this, reason an area in the middle of the continent like Kansas will be much colder in winter than a coastal area like San Francisco at the same latitude.

Latent Heat



- This effect is due to a hidden heat referred to as latent heat : Remember water & solar energy are like water & a sponge.

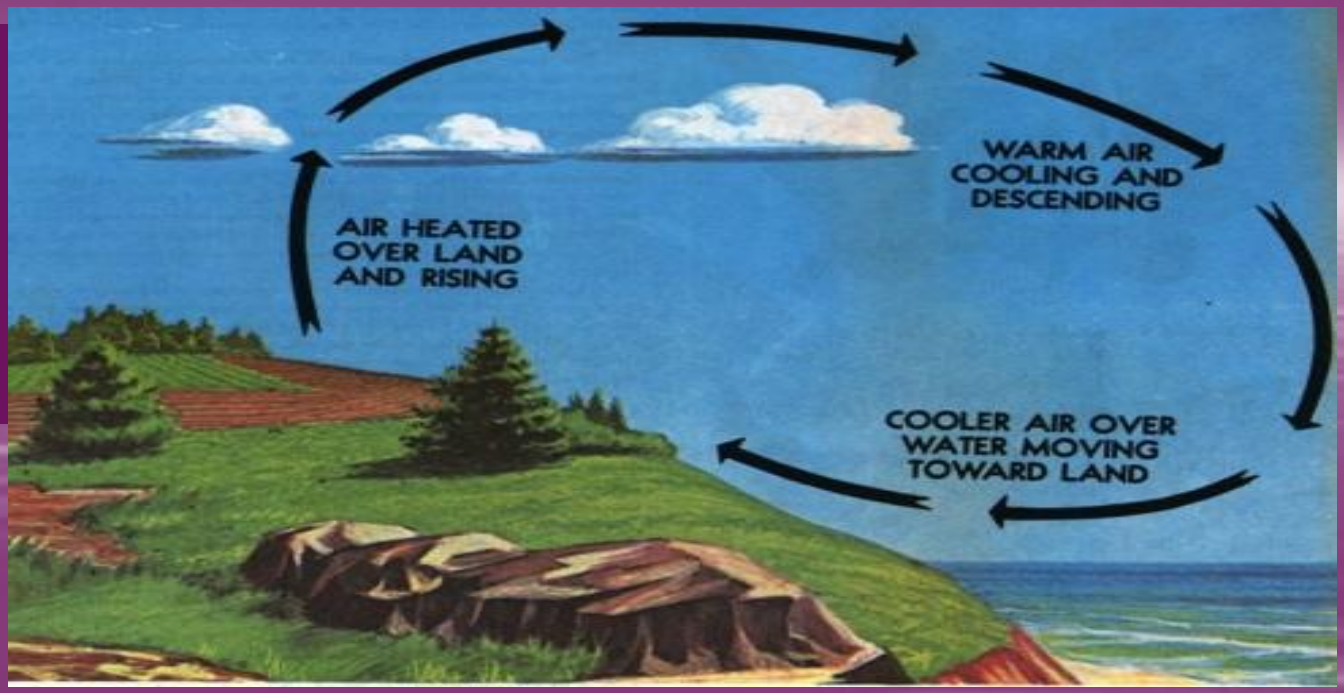
- If you heat water it absorbs the heat turning into vapor, when water cools and condenses the heat used does not disappear. It is instead, released back into the air.

Check for Understanding

- Explain how the climate of a costal region differ than an inland region like Kansas.

Write answers with complete sentences and in your own words.

4. Ocean Currents Affect on Climate

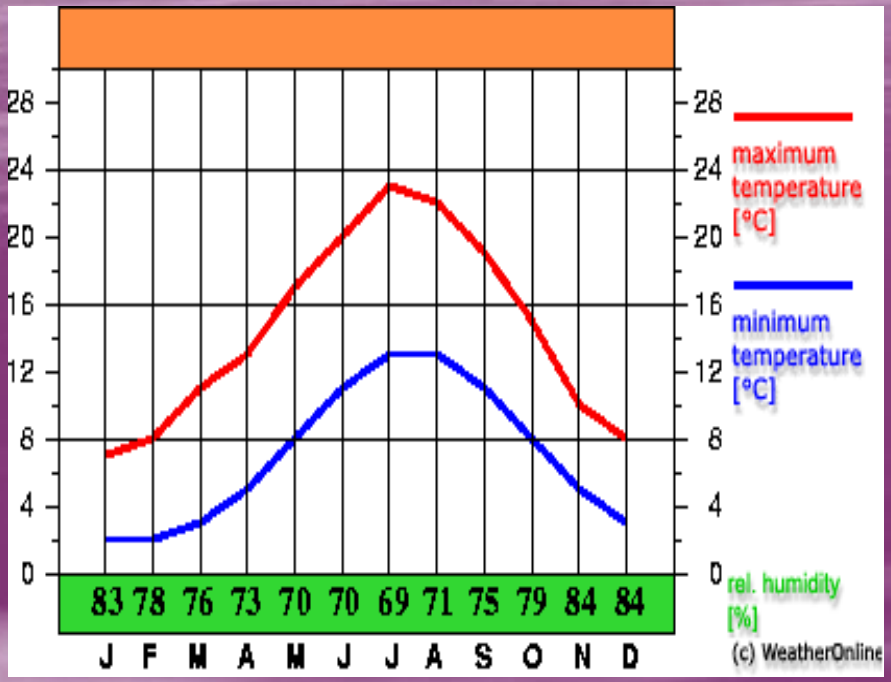


- Winds will consistently blow toward shore. When they do, ocean currents have a "swamp cooler" effect on air masses over land.
- Meaning ocean water driven by currents contacts the air providing a cooling effect to the nearby land mass.

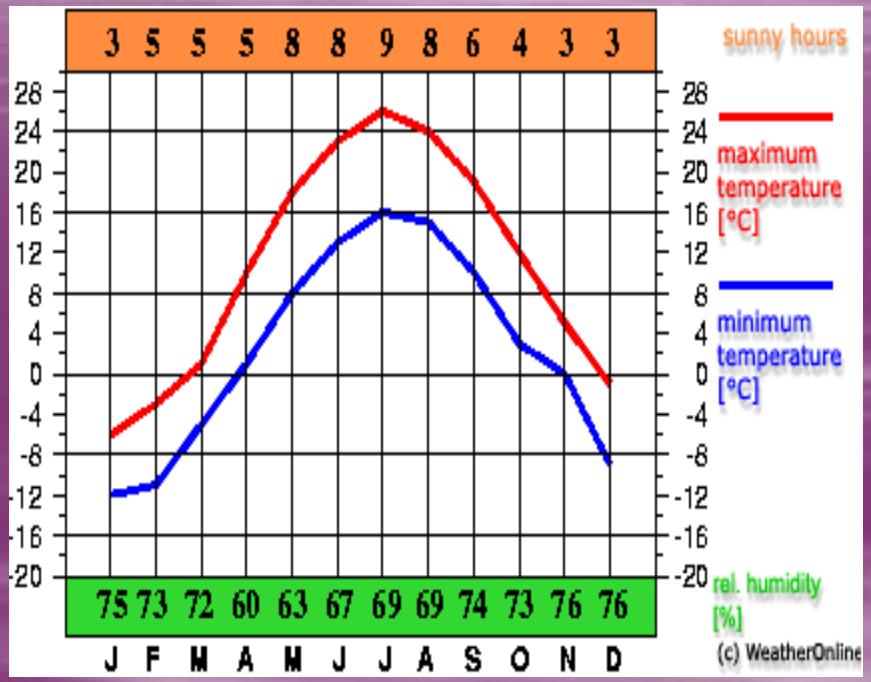
4. Ocean Currents

- For example, the combination of a warm Atlantic current (the Gulf Stream) and steady westerly winds gives northwestern Europe a high average temperature for its latitude.

London, England

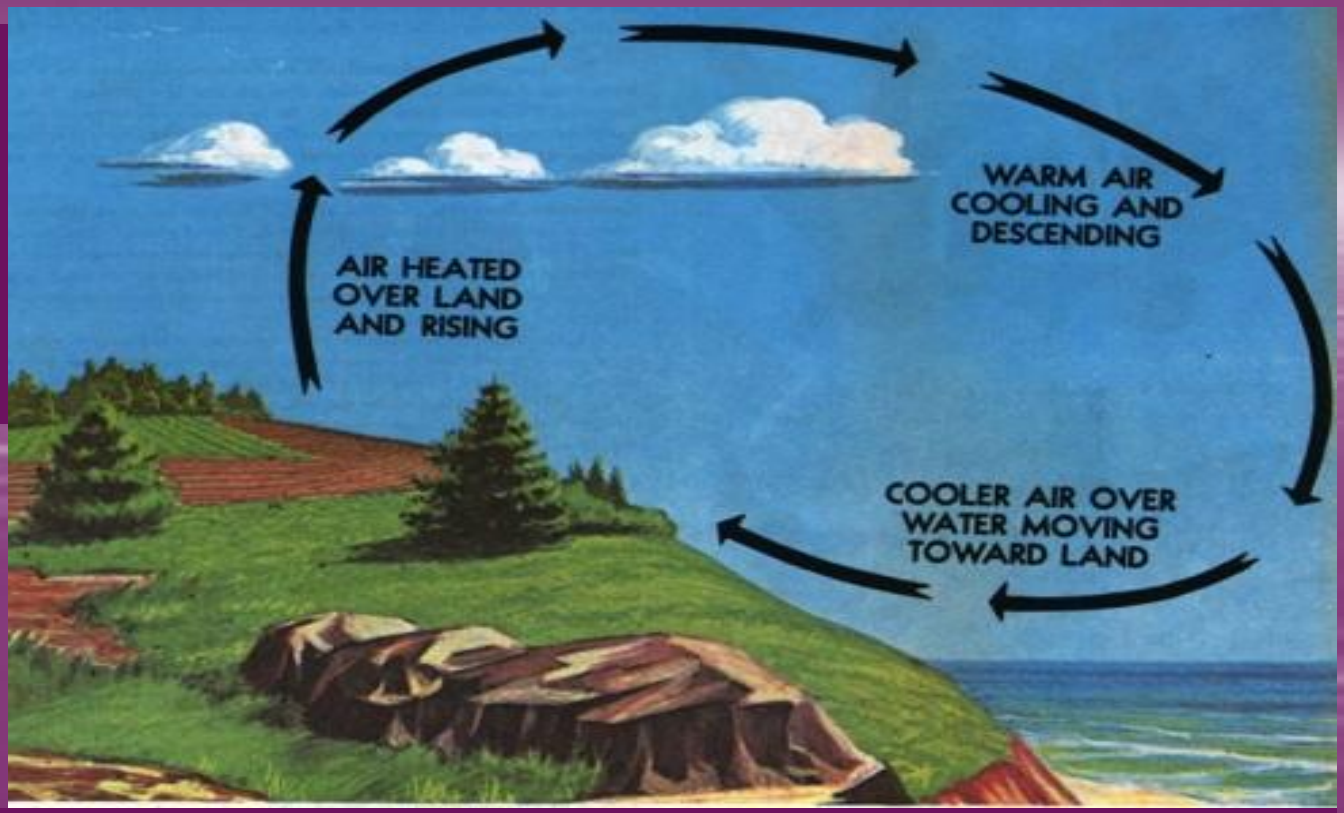


Quebec City, Canada



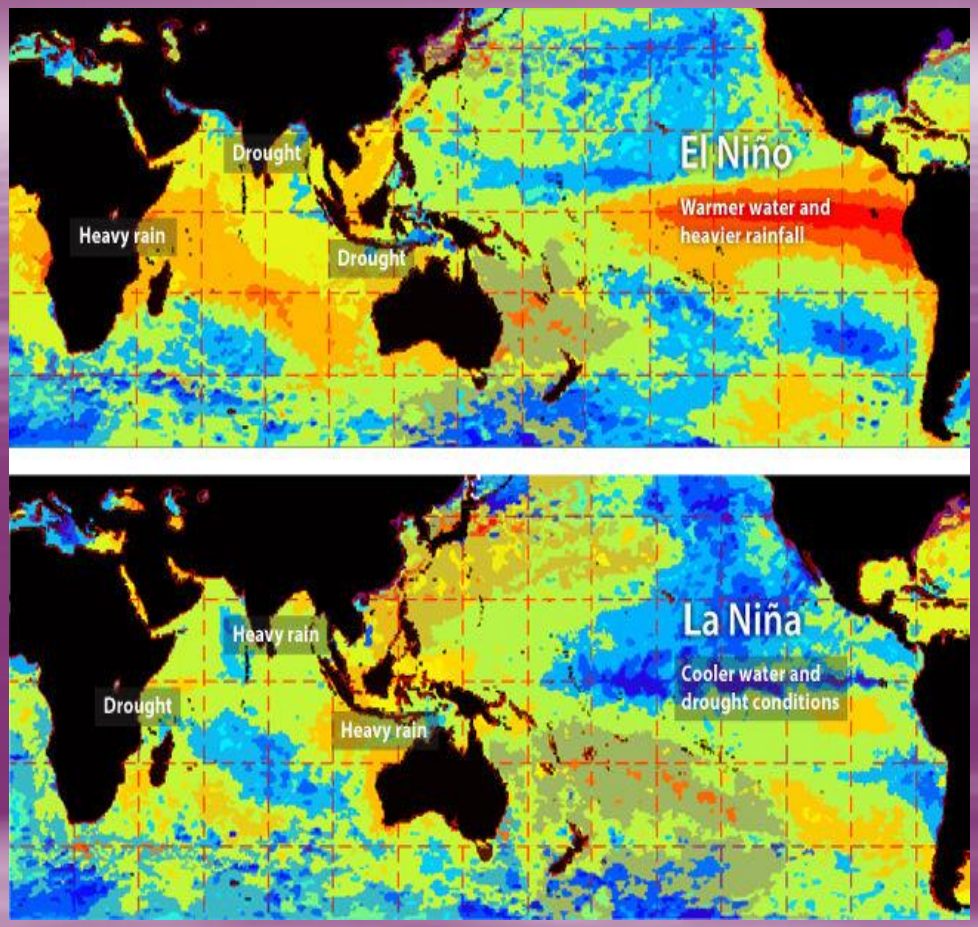
Chapter menu
Resources

What Causes a Sea Breeze?



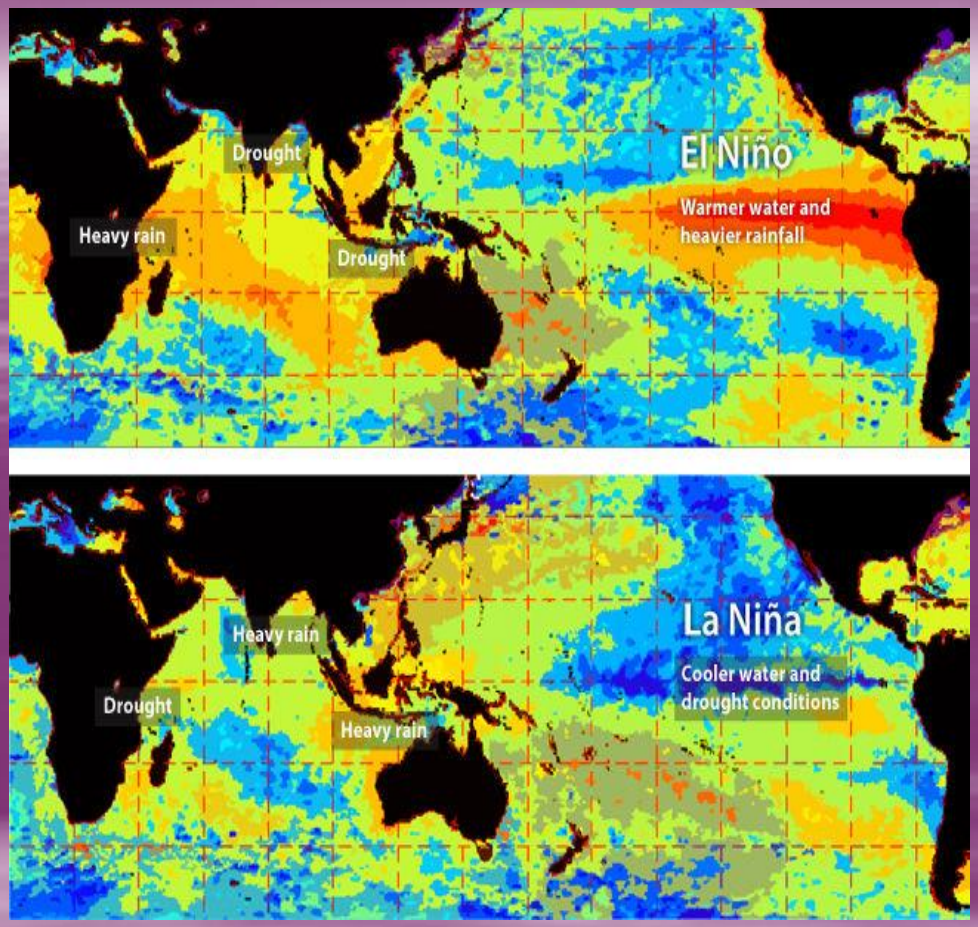
- Just like with Monsoonal weather over southeast Asia, a sea breeze occurs when hot air rises off the continents.
- This leaves a vacuum for cool air to fill creating a sea breeze late in the afternoon.
- California / Rotation

Chapter menu
Resources



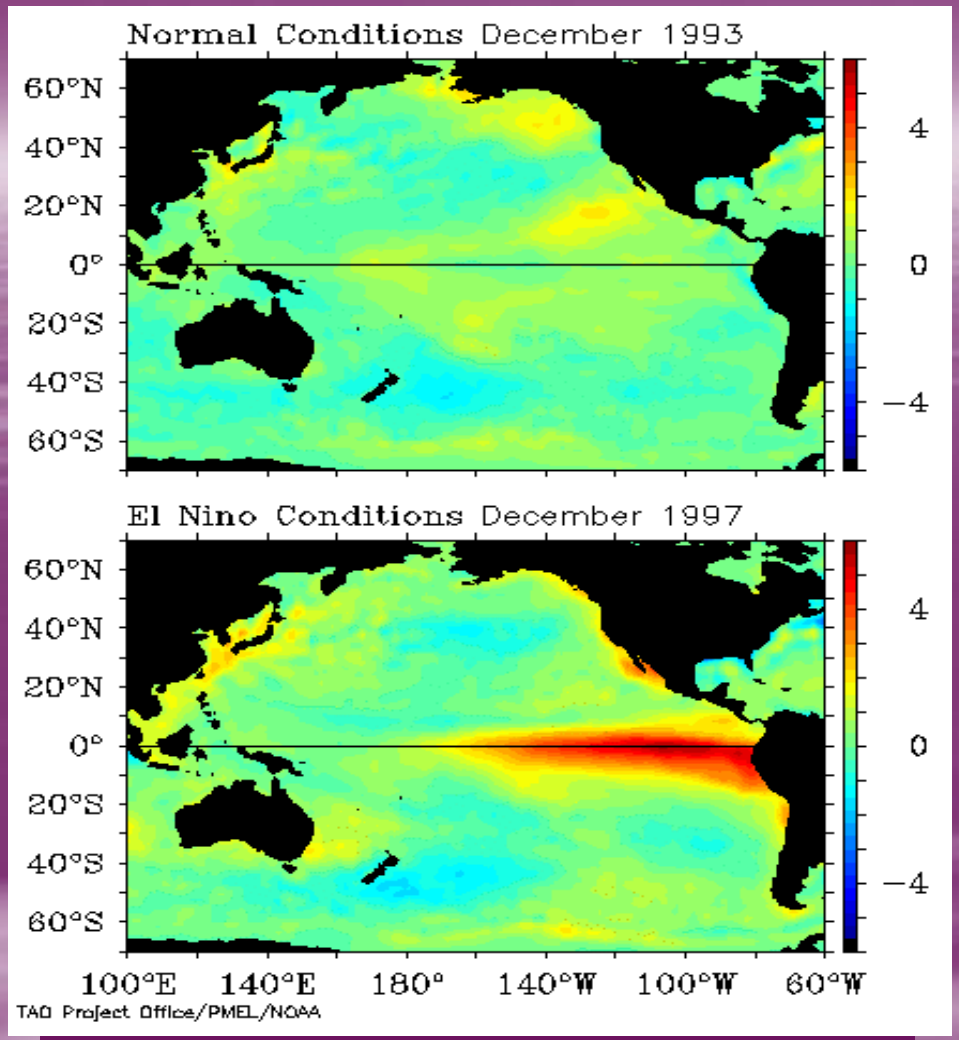
- El Niño/La Niña–Southern Oscillation, is a temporary change of ocean water temperatures (1°F) that occasionally develops off the western coast of South America.
- It can cause climatic changes across the Pacific Ocean and have a big effect on the world's climate.

El Niño Southern–Oscillation



- The warm oceanic phase, El Niño, accompanies high air surface pressure in the western Pacific.
- The cold phase, La Niña, accompanies low air surface pressure in the western Pacific.

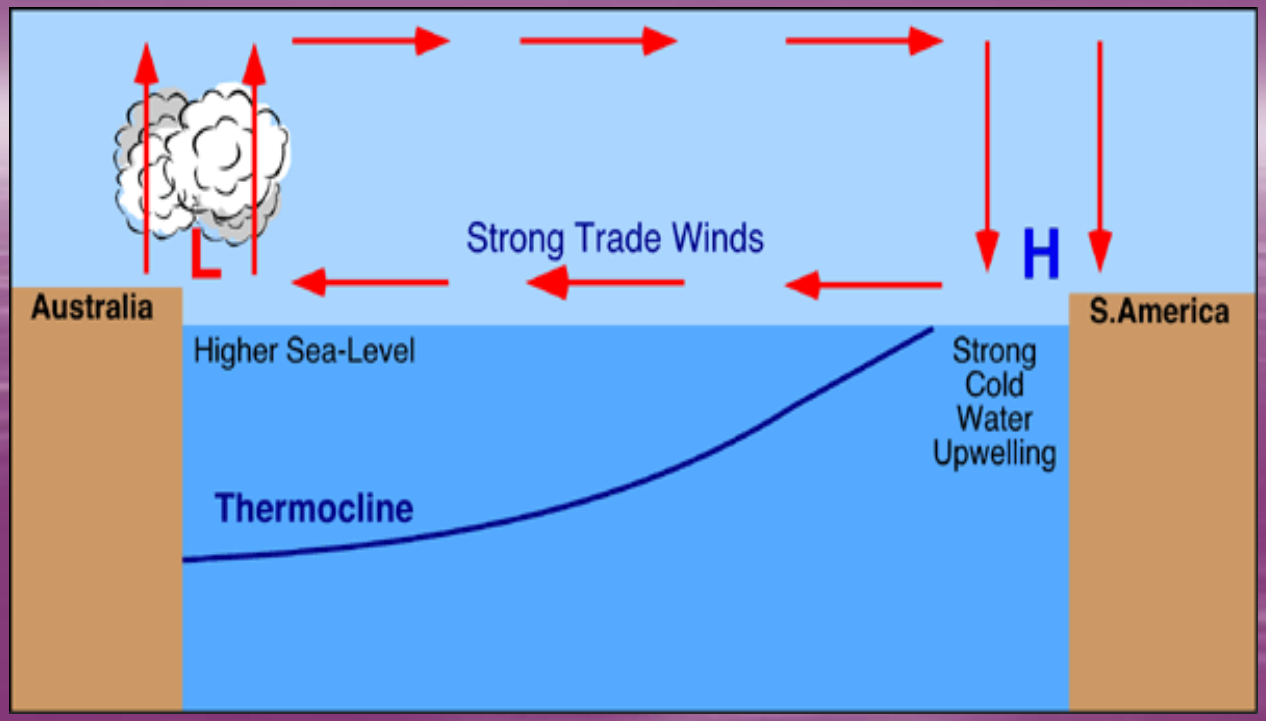
El Niño Southern–Oscillation



- An El Nino event occurs about once every three to seven years.
- It involves the warming of the central and eastern Pacific Ocean, and results in major changes in the jet stream where storms track.
- The name El Niño came from fisherman who noticed this phenomenon started after Christmas.

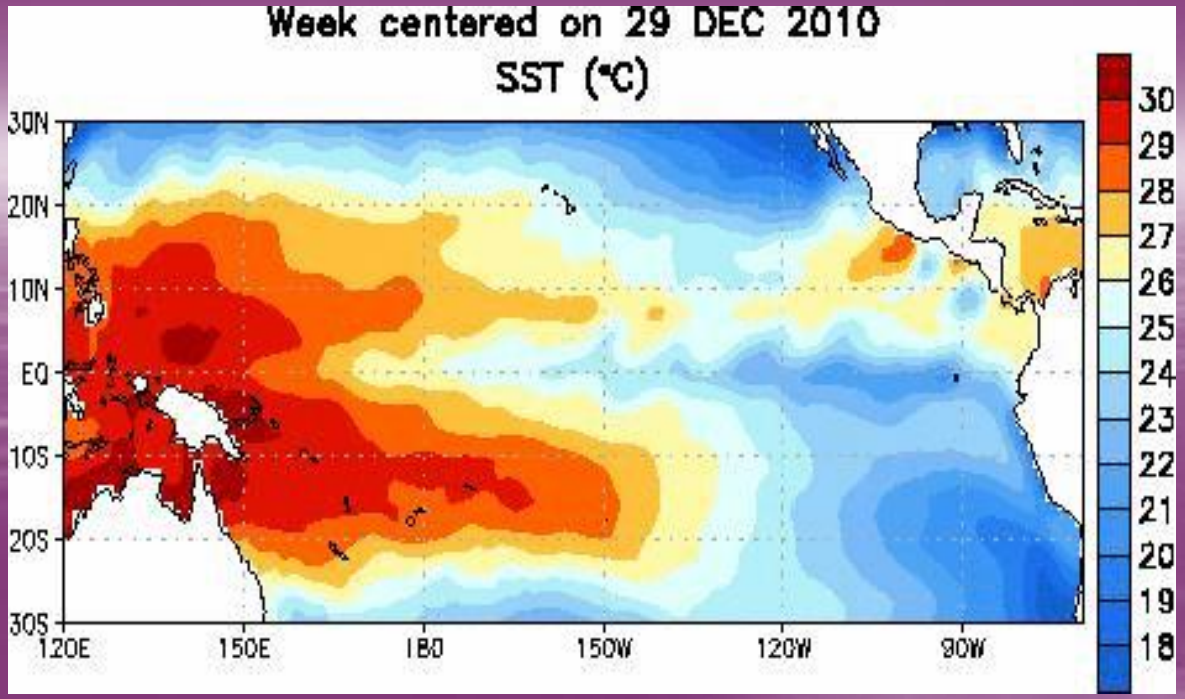
El Niño Southern–Oscillation

Normal Conditions without El Niño



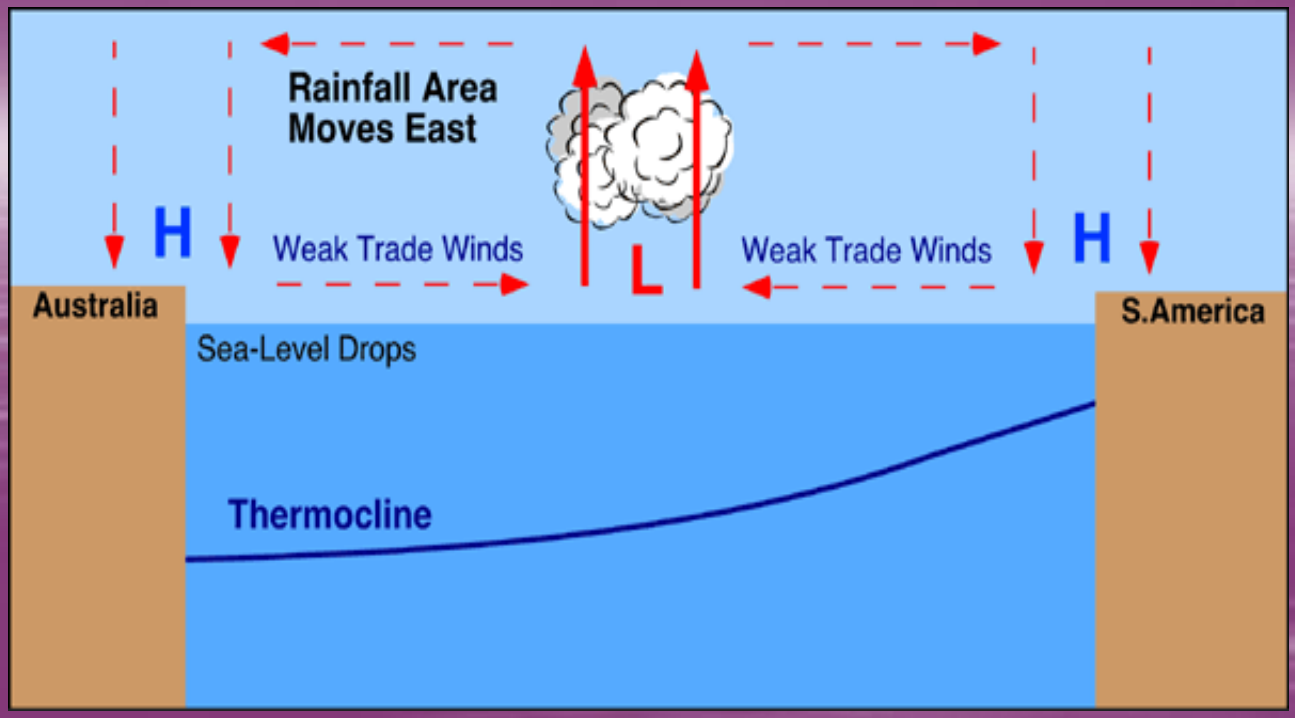
- In normal, non-El Niño conditions, the trade winds blow toward the west across the tropical Pacific Ocean.

Normal Conditions without El Niño



- This creates cool temperatures off South America, due to an upwelling of cold water from deeper layers.
- The cold water is nutrient-rich, supporting a diverse marine ecosystem and major fisheries.

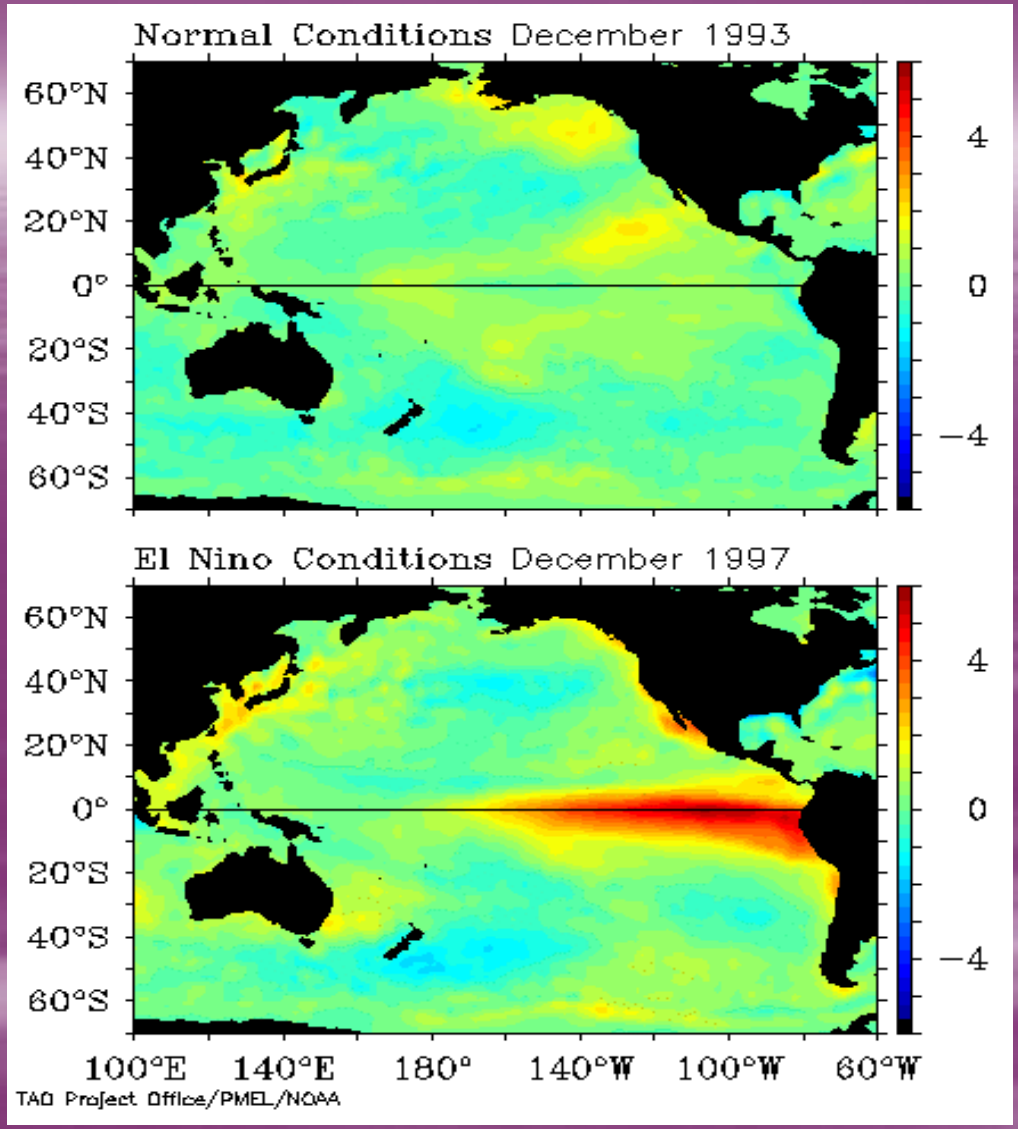
Conditions with El Niño



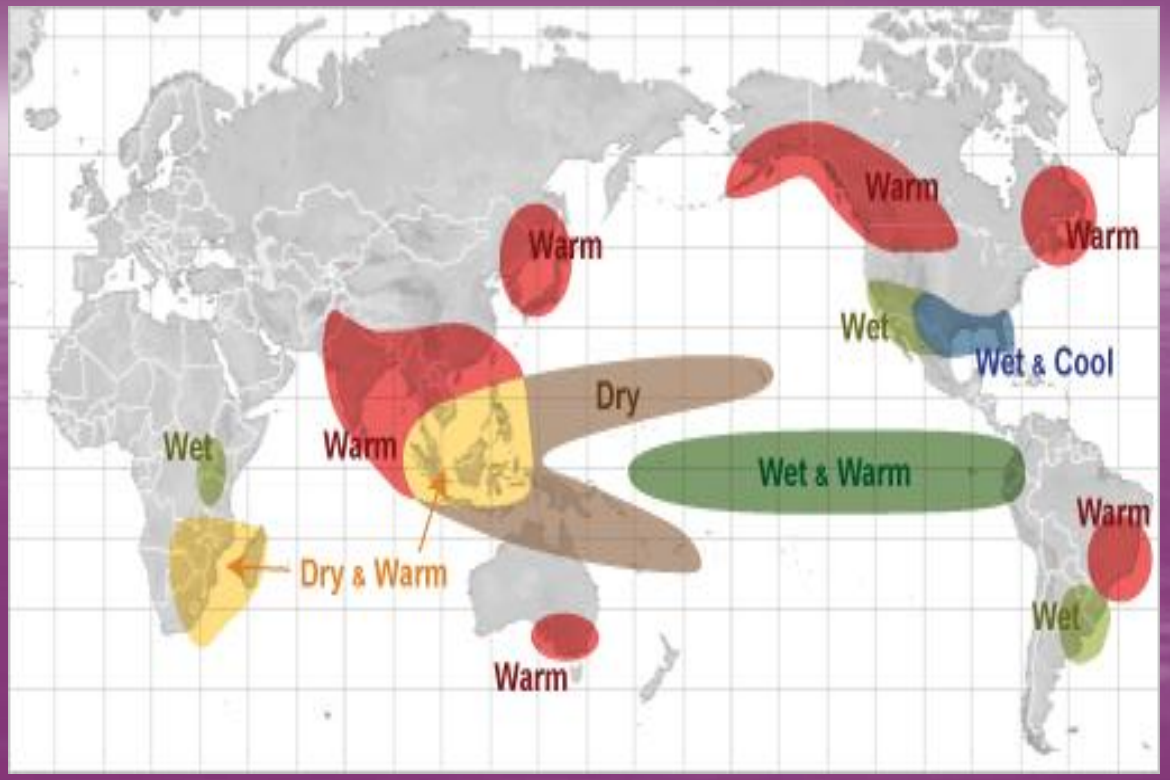
- During the El Niño, trade winds relax in the central and western Pacific leading to a movement to the east of the warm pool of water.
- This warm pool of water moves eastward until it spreads across the entire Pacific Ocean.

- The normally cool water located off the South American coast is replaced by much warmer waters.

Conditions with El Niño



Consequences of the El Niño



- Without the trade winds, the upwelling which supplies the cooler sub-surface ocean water is weakened forcing an ultimatum to marine organisms: leave or die.

Consequences of the El Niño

- The reduction of food from the ocean is not the only consequence of the El Niño.
- A strong El Niño is often associated with wet winters over the southeastern US, as well as drought in Africa, Indonesia and Australia.

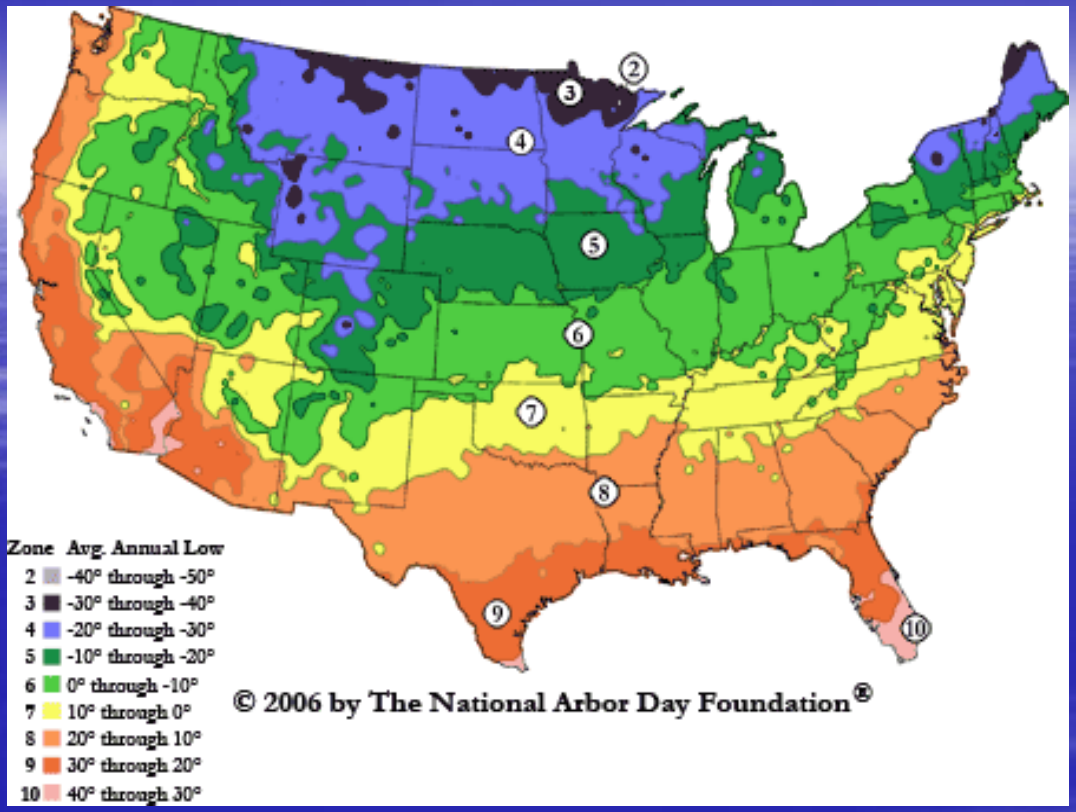
Chapter menu
Resources

Check for Understanding

- Describe normal water conditions in the South Pacific without an El Nino year.

- How does El Nino effect the global climate?

Write answers with complete sentences and in your own words.



- Earth has three major types of climate zones:
  - 1. Tropical
  - 2. Middle-latitude
  - 3. Polar.
- Each zone has distinct temperature characteristics, including a specific range of temperatures.

Lesson 5 - Climate Zone

Further reading

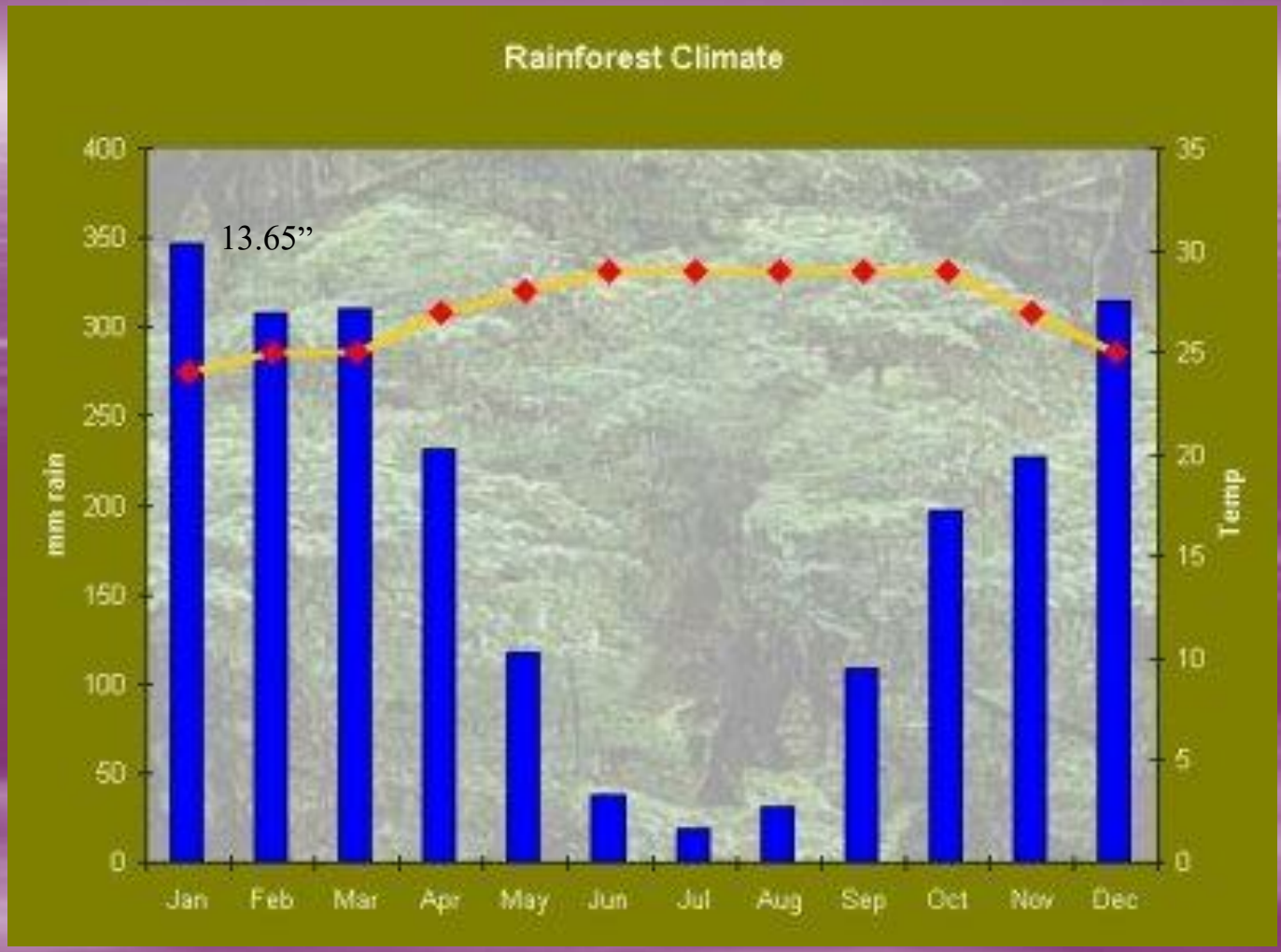
Malaysia 1

Malaysia 2

Tropical Climates

- Tropical climates are characterized by high temperatures and heavy precipitation during at least part of the year.
- These climates are controlled by warm equatorial air masses and are found from 15° to 25° latitude.

Tropical Climates



Chapter 25

- Within the tropical zone, there are three types of tropical climates:
- 1. Tropical rain forest
- 2. Tropical desert
- 3. Savanna.

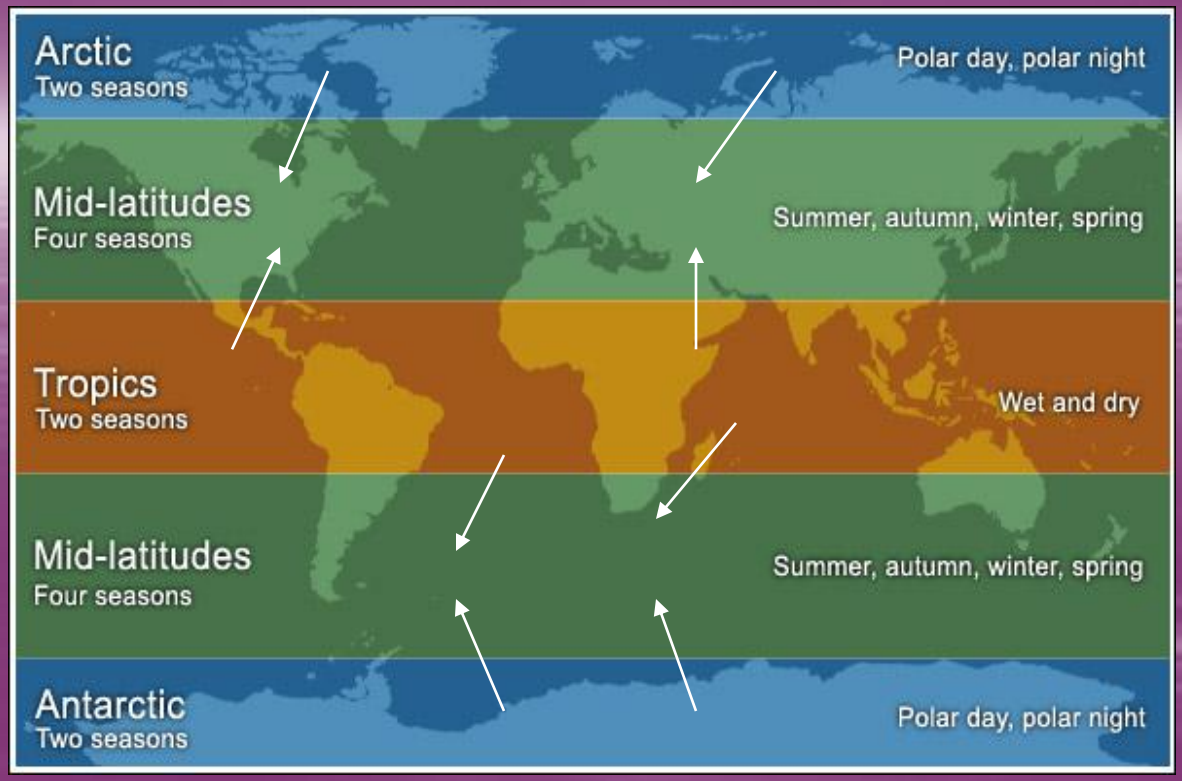
Tropical Climates

Check for Understanding

- What degree latitude are the Tropics?
- Why is it that the Tropics only have one or two seasons a year.

Write answers with complete sentences and in your own words. Be able to justify your response.

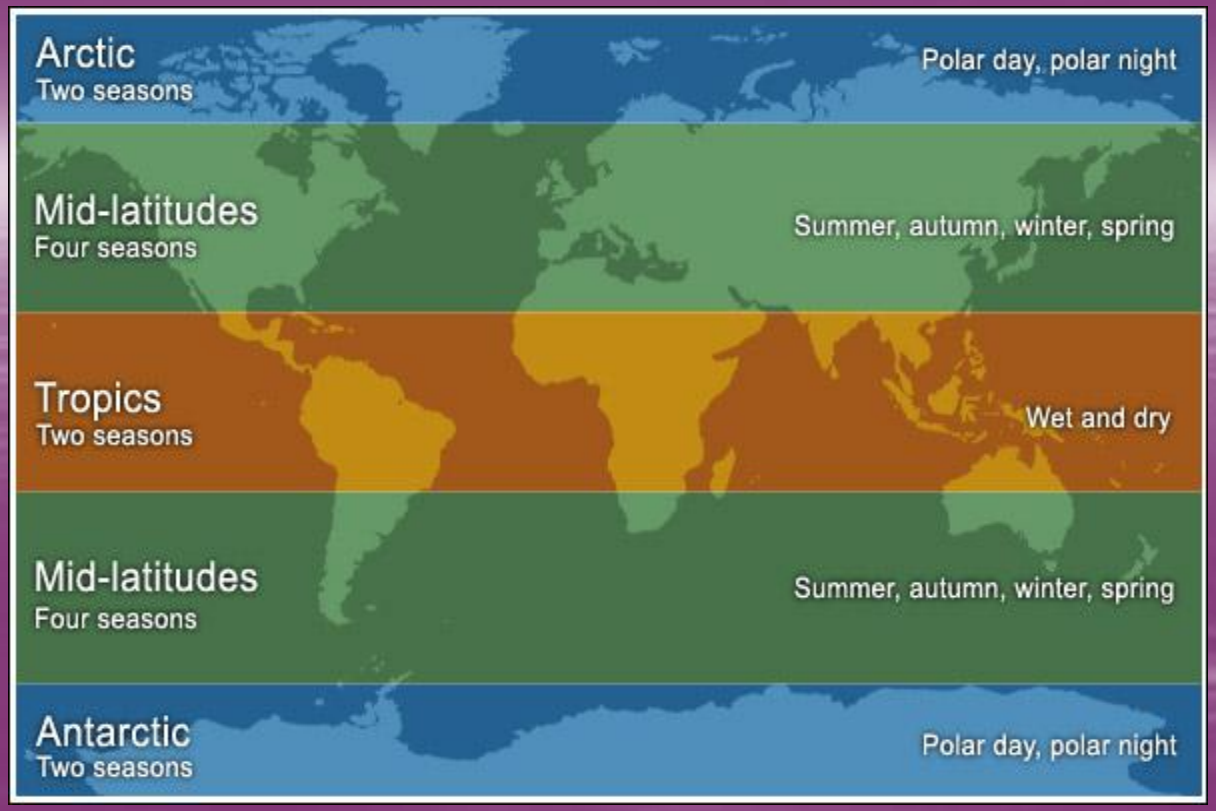
Middle-Latitude Climates



- Climates in this zone are affected by two different air-masses.
- The tropical air-masses are moving towards the poles and the polar air-masses are moving towards the equator.

Chapter menu
Resources

Middle-Latitude Climates

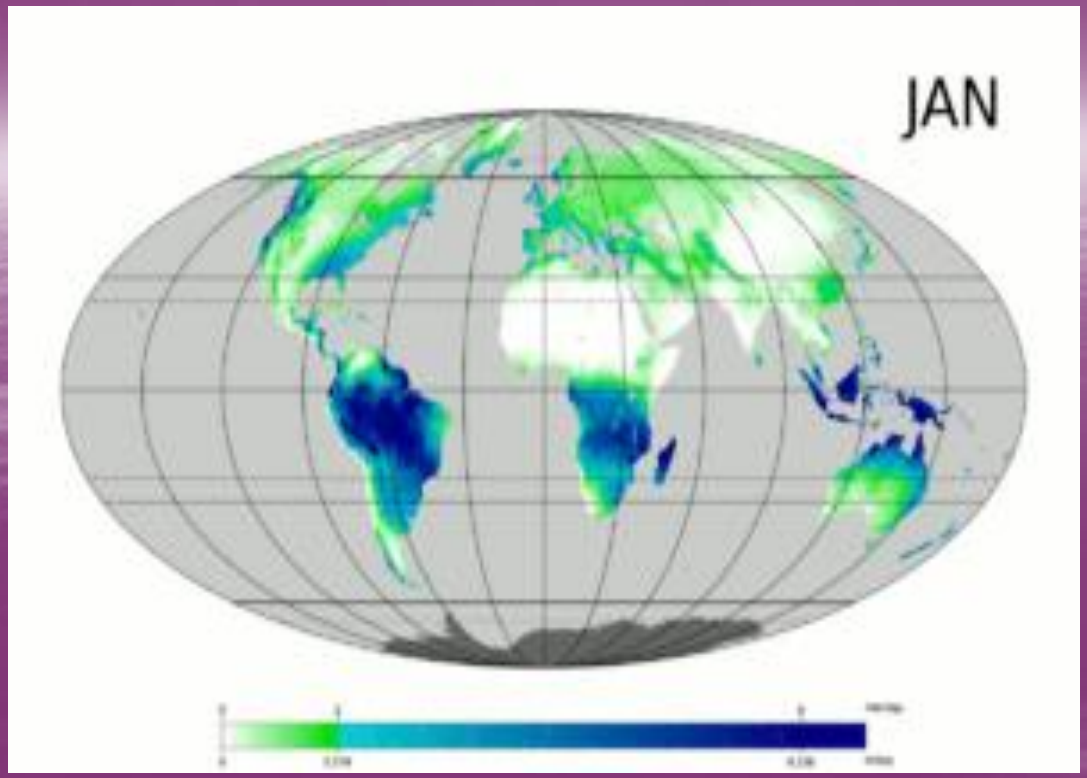


- These two air masses are in constant conflict and while either air mass may dominate the area, neither has exclusive control.
- Middle-latitude climates are found from 30° to 50° of latitude.

Chapter menu
Resources

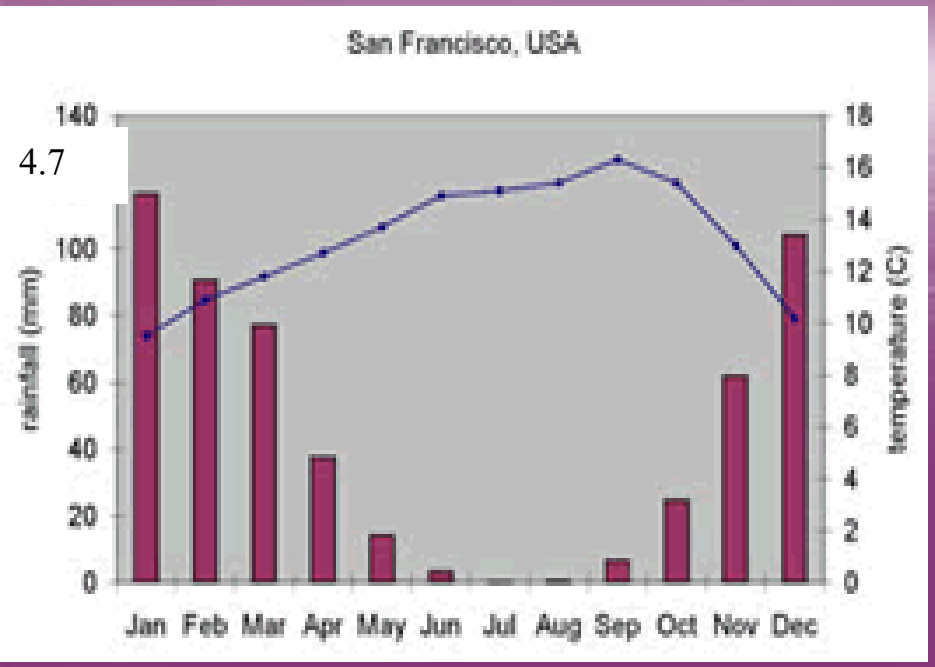
Middle-Latitude Climates

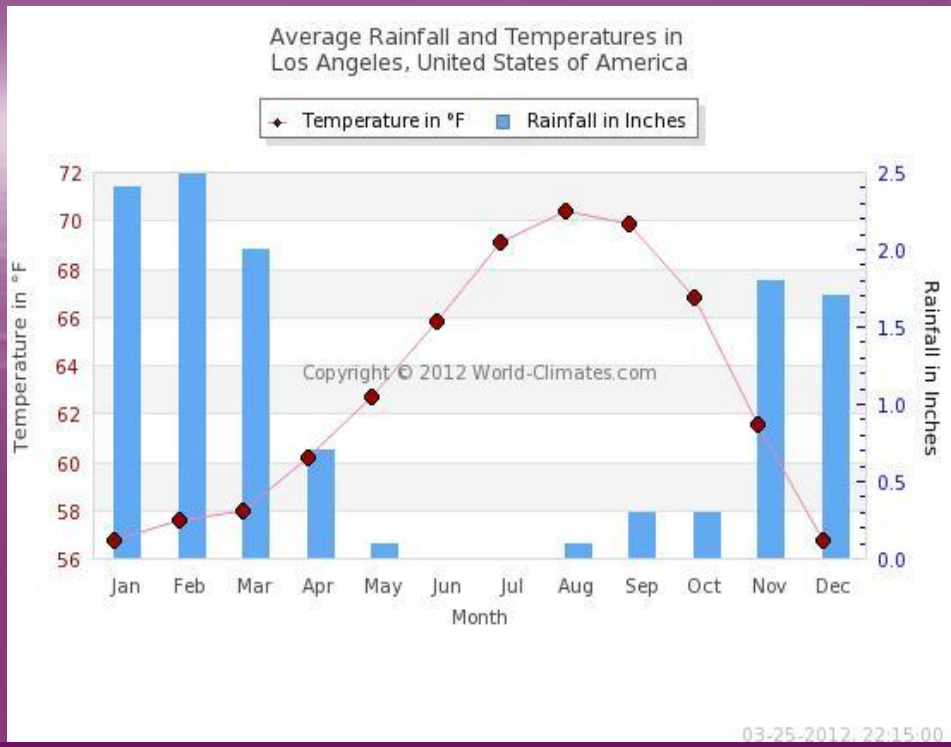
- There are five middle-latitude climates:
- (1) Marine west coast
- (2) Steppe
- (3) Humid Continental
- (4) Humid Subtropical
- (5) Mediterranean



California Climates

- In California, average precipitation decreases as you go southward.
- In addition, average temperatures increase as you go southward because of a decrease in latitude.





- Take for example the three major cities average rainfall a year.
- San Francisco ~ 23 inches
- Los Angeles ~ 14 inches
- San Diego ~ 12 inches

California Rainfall

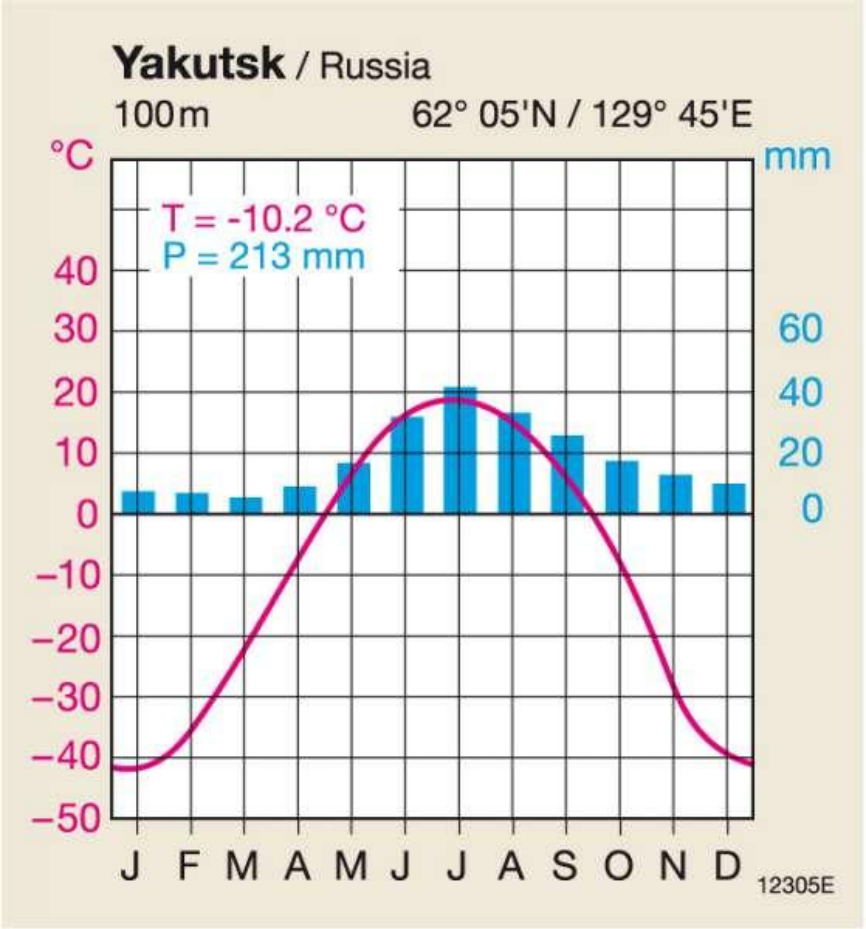
Chapter menu

Resources

- There are a variety of climate zones in California.
- Mediterranean.
- California has mild winters and warm, dry summers compared to the rest of the world.

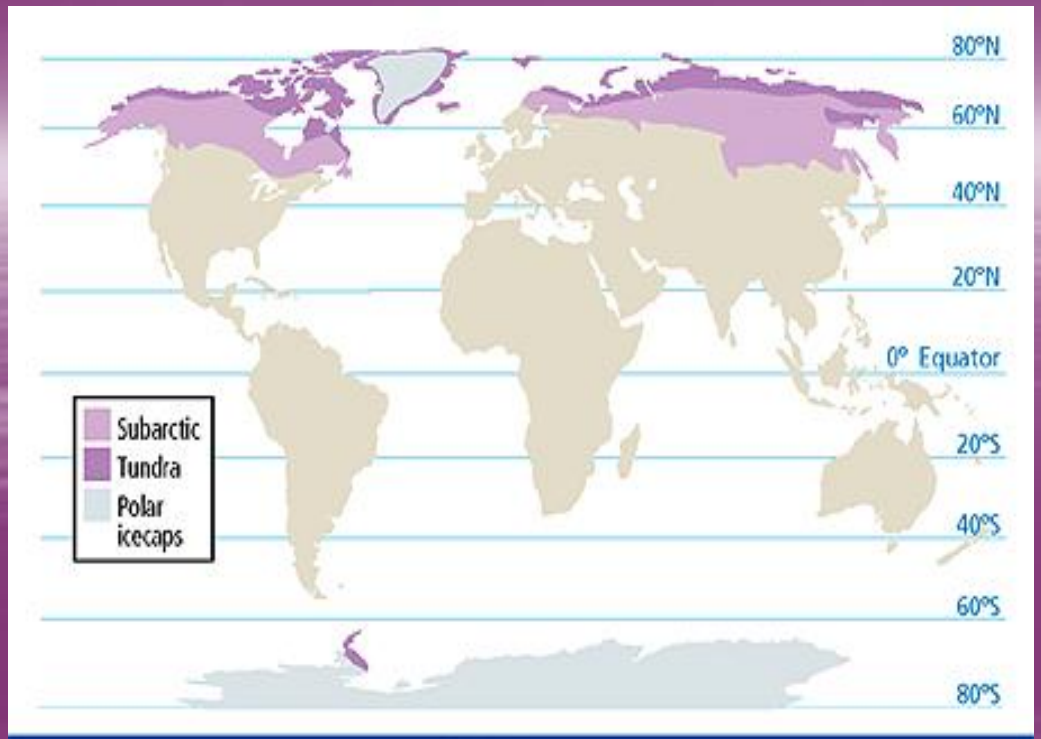
California Climates

Chapter menu
Resources



Polar Climates

- Polar climates are characterized by average temperatures near or below freezing.
- Polar and arctic air masses dominate these regions.
- Polar climates are found from 50° to 90° latitude



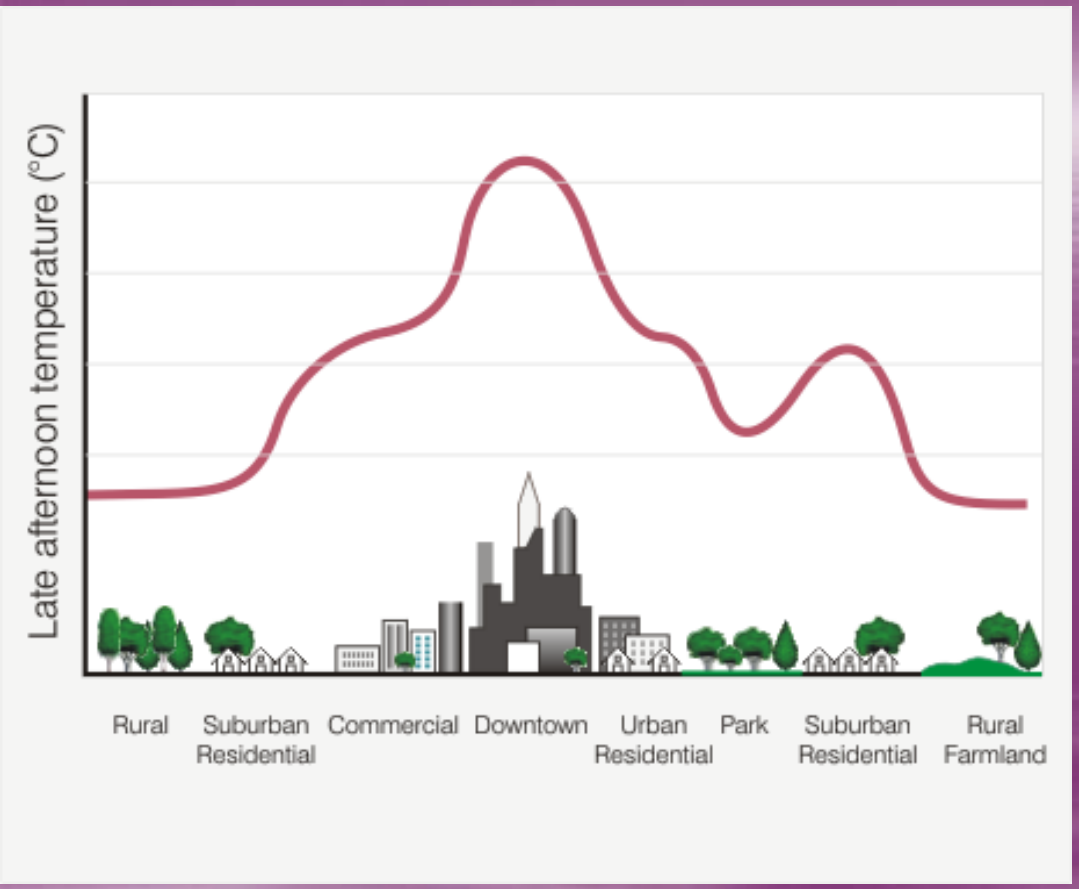
Polar Climates

Climate	Temperature and precipitation	Description
Subarctic	largest annual temperature range (63°C); annual precipitation of 25 to 50 cm	characterized by evergreen trees; brief, cool summers and long, cold winters
Tundra	average temperature below 4°C; annual precipitation of 25 cm	characterized by treeless plains; nine months of temperatures below freezing
Polar icecaps	average temperature below 0°C; low annual precipitation	characterized by little or no life; temperatures below freezing year-round and high winds

- There are three types of polar climates:
- (1) Subarctic
- (2) Tundra
- (3) Polar icecap

Polar Climates

Chapter menu
Resources



- A microclimate is the climate of a small area that is different from the area around it.
- Microclimates are influenced by density of vegetation, by elevation, and by proximity to large bodies of water.

Local Microclimates

- In a city microclimate, pavement and buildings absorb and reradiate solar energy, which raises the temperature of the air above.

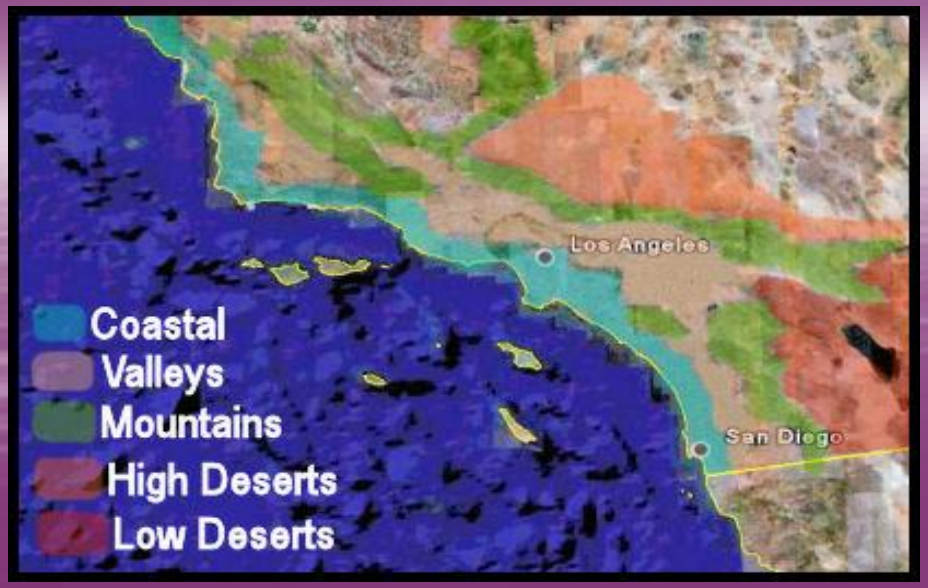
City Microclimate

- In contrast, vegetation in rural areas does not reradiate as much energy, so temperatures in those areas are lower.

Rural Climates

Effects of Large Bodies of Water

- Microclimates near large bodies of water have a smaller range of temperatures and higher annual precipitation than other locations at the same latitude.



6 Types of Microclimates

- Here in southern California there are 6 distinct “microclimate" zones.
- Coastal (Including...San Diego and Santa Barbara)
- City (Metro/ Downtown)
- Valley (Including... La Verne, Van Nuys and Covina)

- Mountain (Including... Big Bear, Lake Arrowhead)
- High Desert (Including... Palmdale, Hesperia)
- Low Desert (Including... Palm Springs and Borrego Springs)

6 Types of Microclimates

Check for Understanding

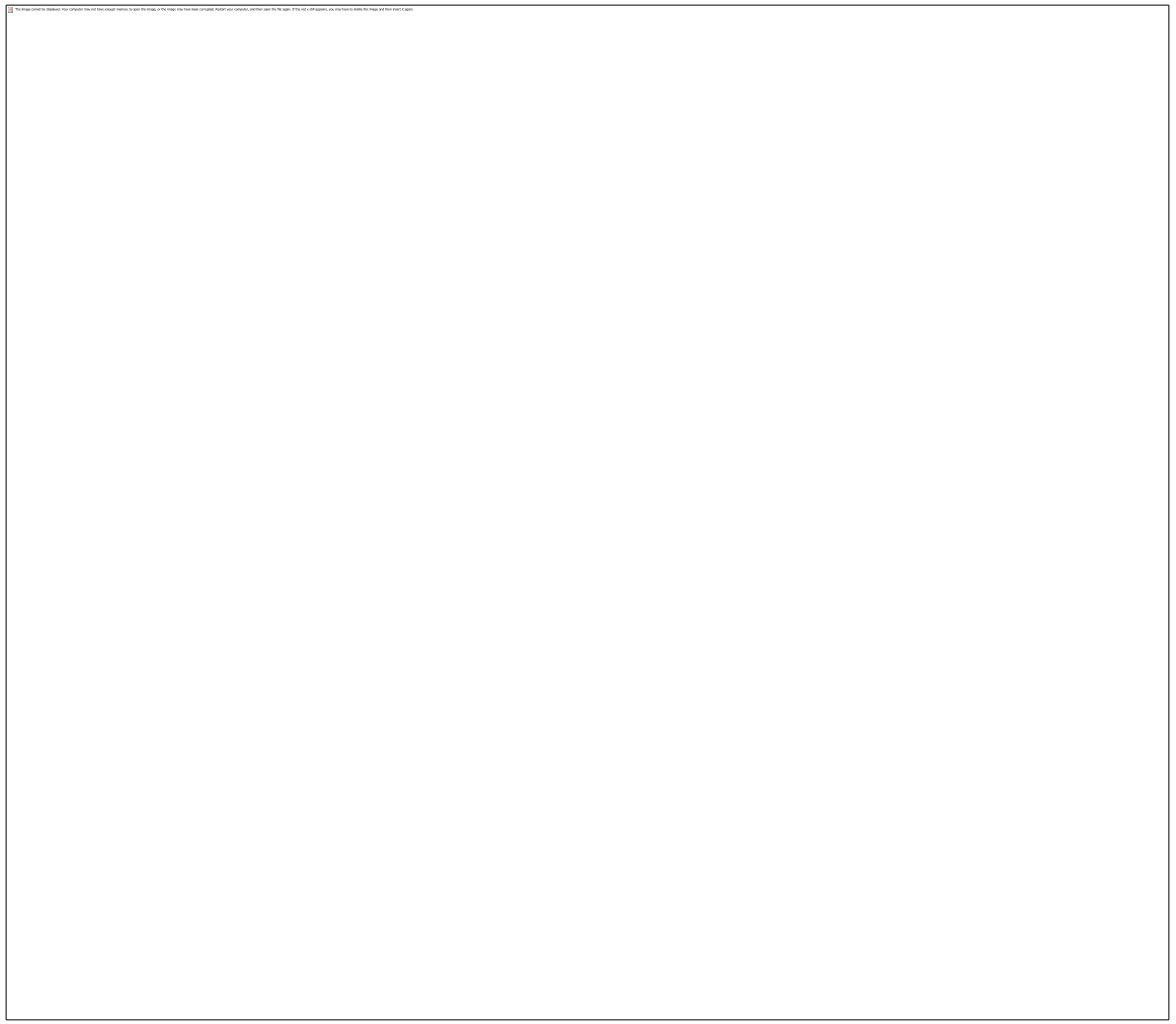
1. Describe Polar climates and Mid-latitude climates?
   - 3 Characteristics Each

Write answers with complete sentences and in your own words.

LOL!

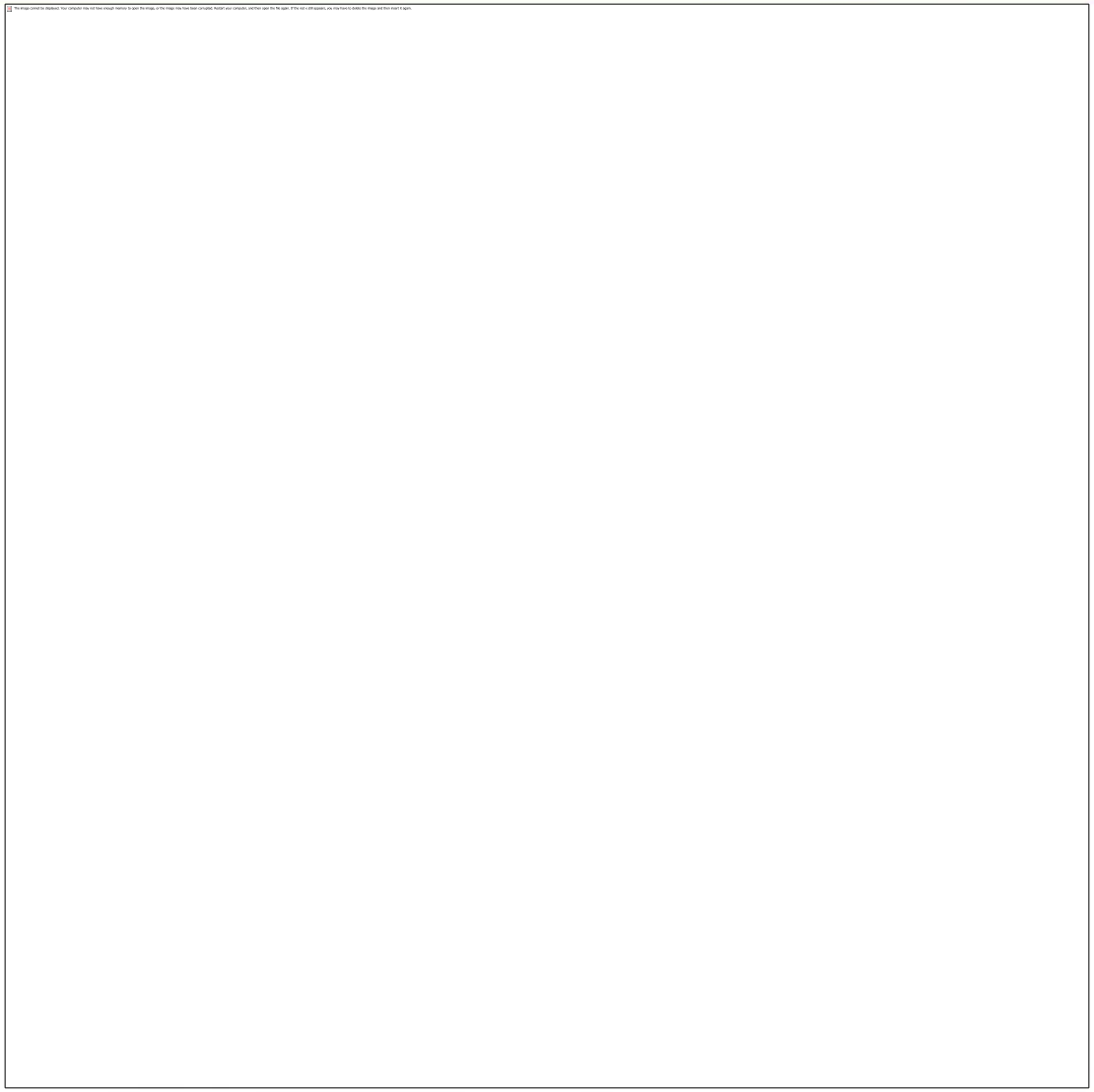
Chapter 25

Tropical Climates

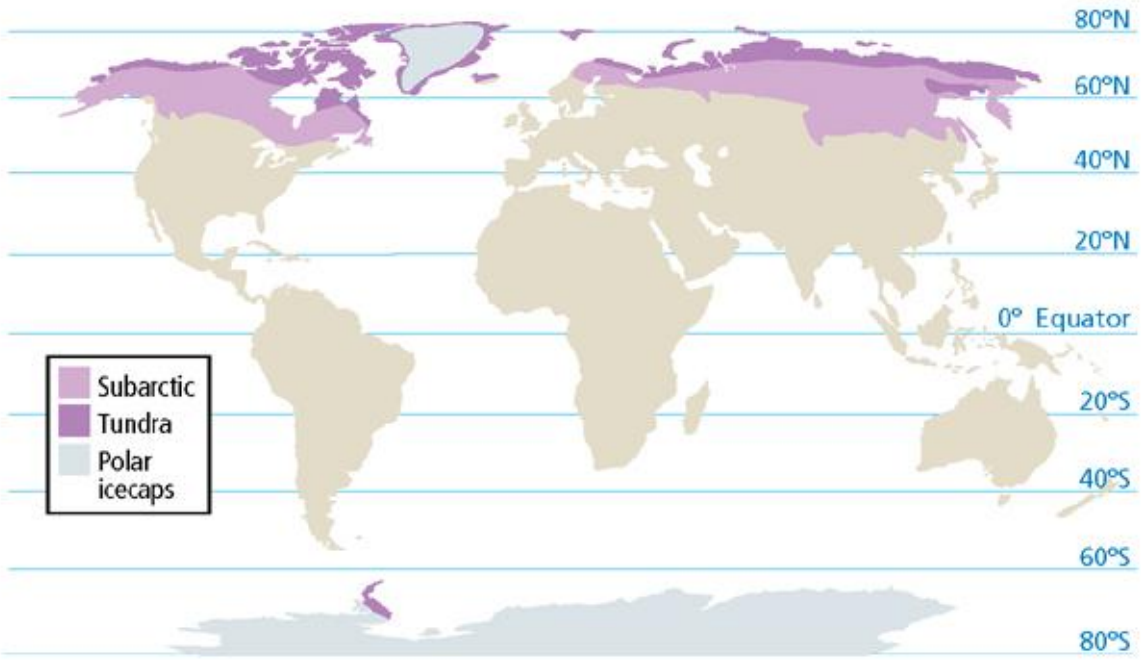


Chapter 25

Middle-Latitude Climates



Polar Climates



Polar Climates

Climate	Temperature and precipitation	Description
Subarctic	largest annual temperature range (63°C); annual precipitation of 25 to 50 cm	characterized by evergreen trees; brief, cool summers and long, cold winters
Tundra	average temperature below 4°C; annual precipitation of 25 cm	characterized by treeless plains; nine months of temperatures below freezing
Polar icecaps	average temperature below 0°C; low annual precipitation	characterized by little or no life; temperatures below freezing year-round and high winds

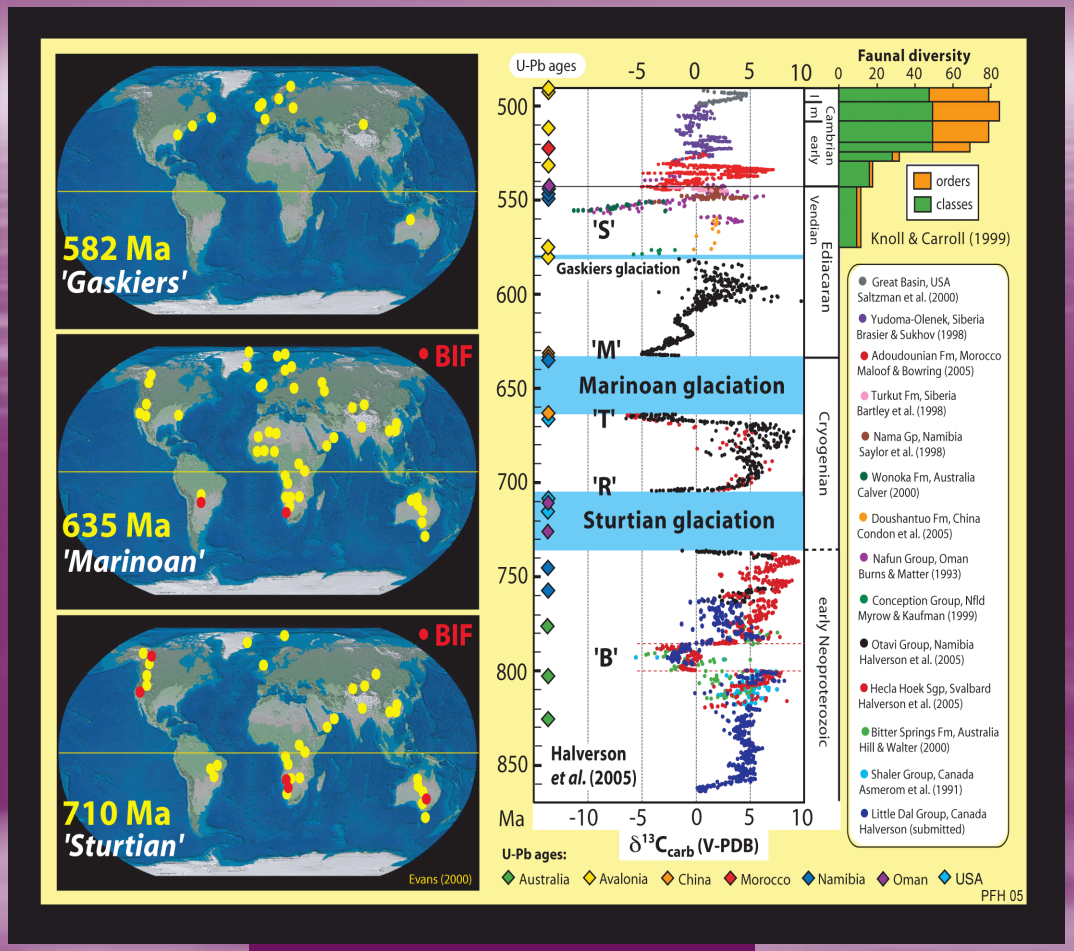
- What we know about Earth's past climate comes from clues that remain in rocks, ice, trees, corals, and fossils.
- These clues tell us that the Earth's climate has changed many times before.

Lesson 6 - Causes of Climate Change

Chapter 25

- There have been times when most of the planet was covered in ice (also known as the Ice Ages) and there have also times of much warmer periods.

Ice Age



- Scientist have found evidence of at least four major Ice Ages in the last 2 million years.
- During an Ice Age temperatures would dip by 50°F around the world.

Ice Age

Chapter menu
Resources

Ice Age

- Obvious topography scars.

Chapter menu

Resources

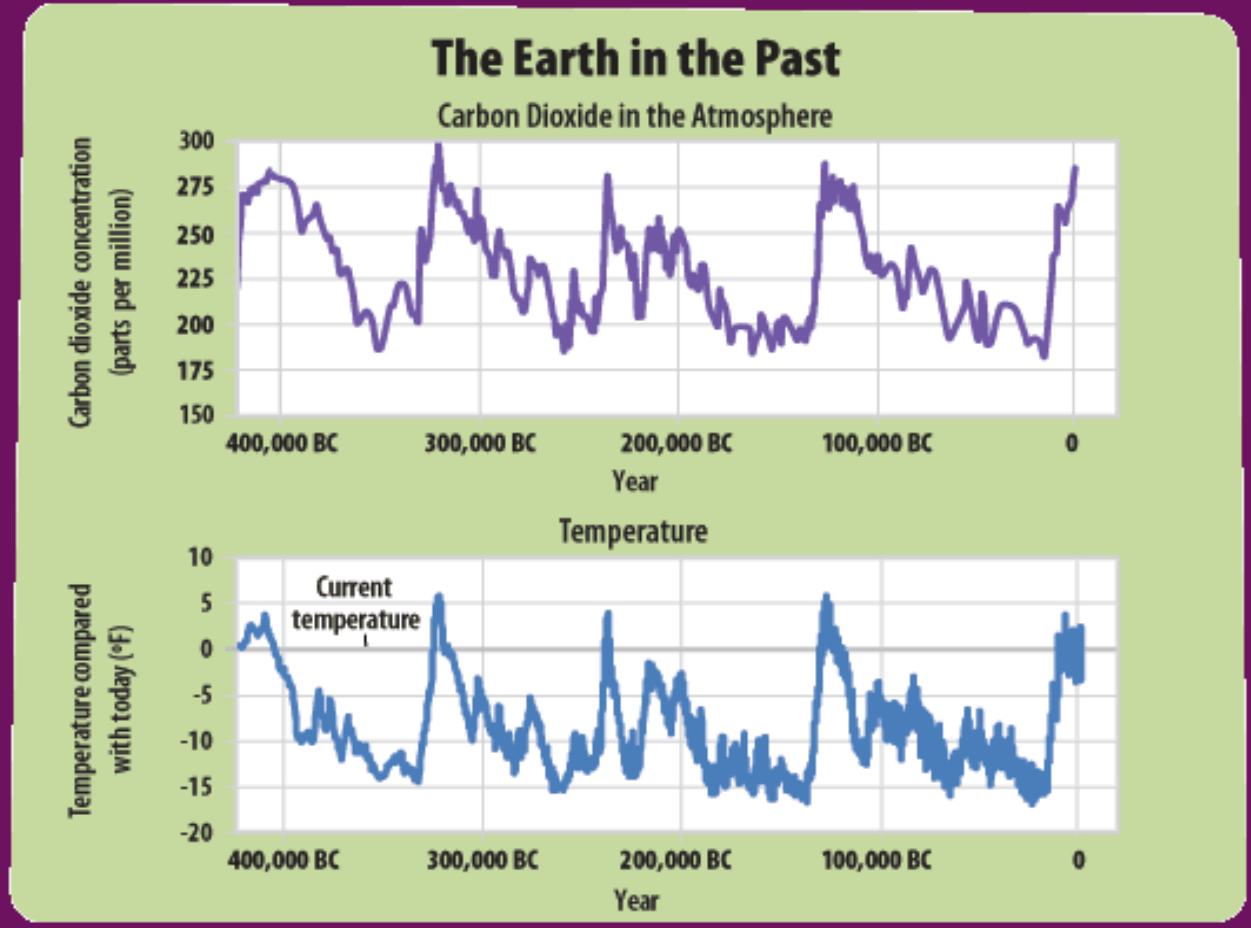
Ice Age

- The thickness of a ring depends on what the weather was like during the year in which it grew.

Chapter menu

Resources

- Over at least the last 650,000 years, temperatures and carbon dioxide levels in the atmosphere have increased and decreased in a cyclical pattern.



Ice Age

Chapter menu
Resources

Causes of Climate Change

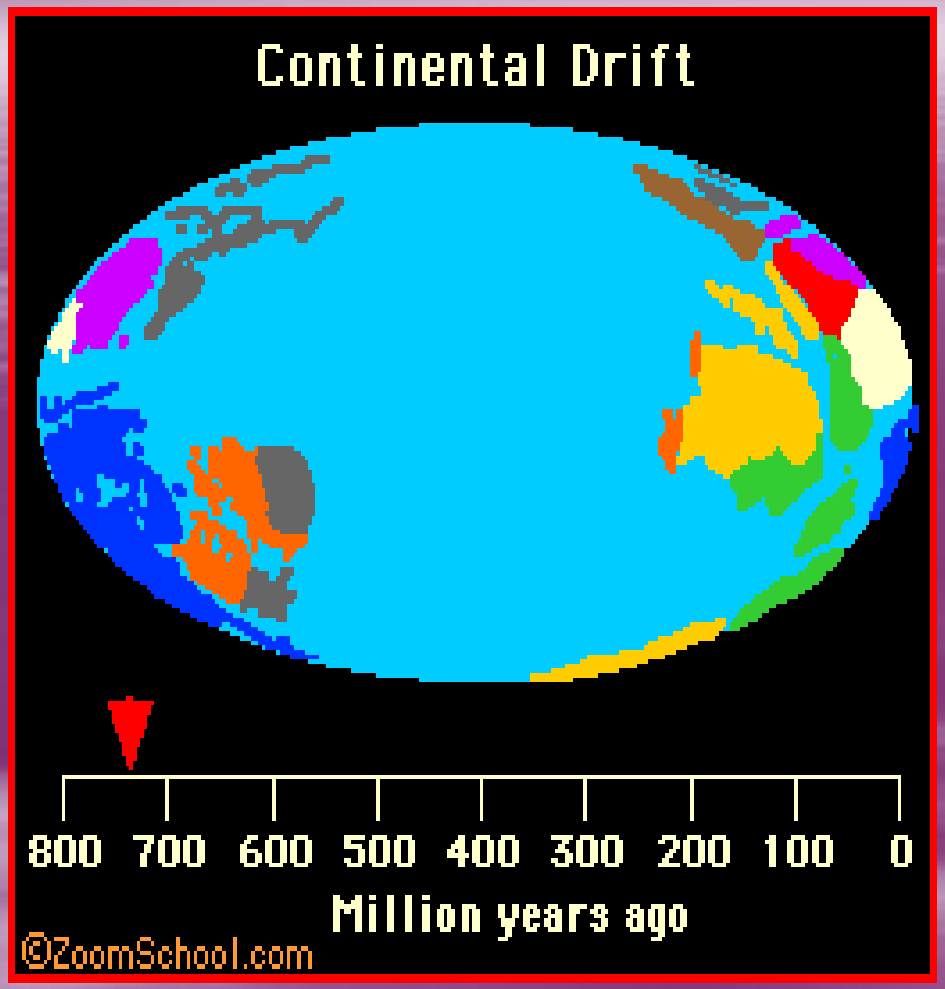
- Scientists divide the causes into two categories:
- (1) Natural causes
- (2) Human causes.

Chapter menu
Resources

- The earth's climate is influenced and changed through natural causes like:

- (1) Continental Drift
- (2) Volcanic eruptions,
- (3) Ocean current,
- (4) Earth's orbital changes
- (5) Solar variations

Natural Causes of Climate Change



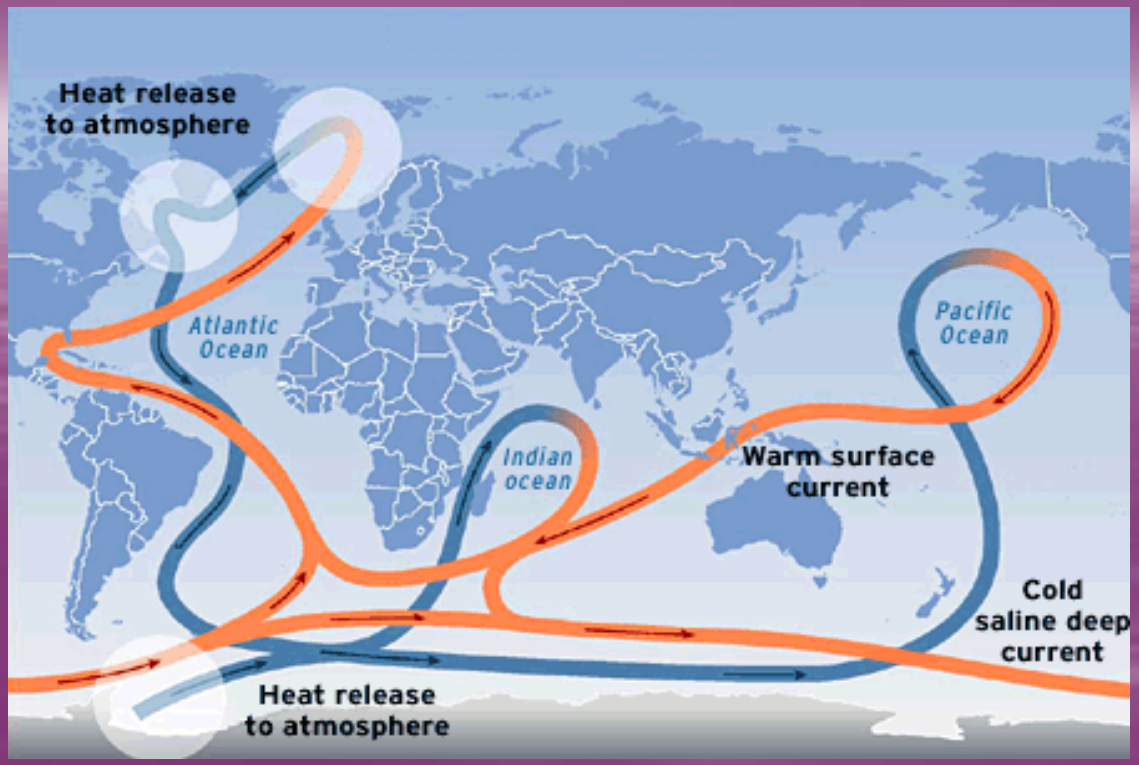
- The drifting of continents both together and then apart would cause dramatic climate changes by changing the topography of Earth.

1. Continental Drift

2. Volcanic Eruptions

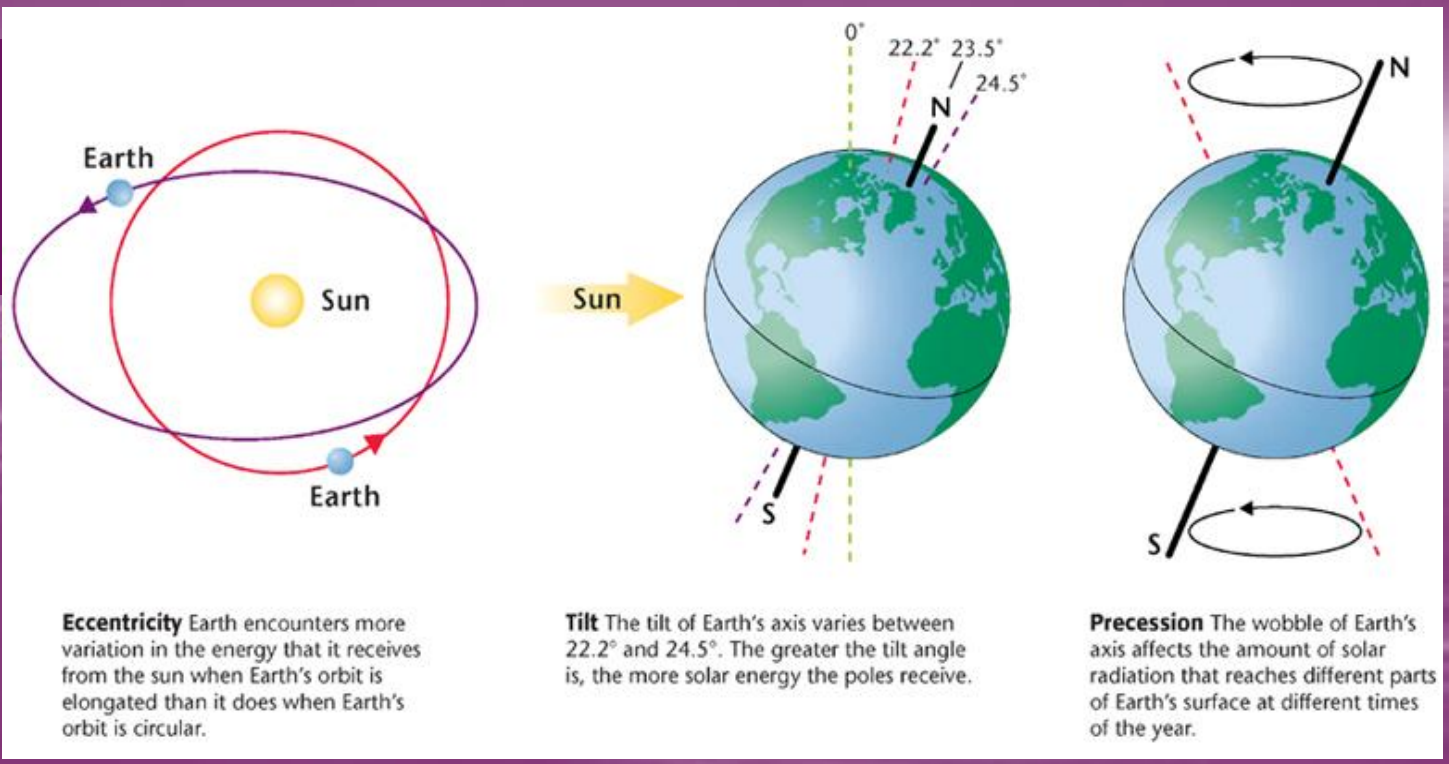
- The movement of continents could induce volcanoes, by creating new plate boundaries.
- Volcanic activity would change the atmosphere with more greenhouse gases and by blocking sunlight for long periods of time.

3. Ocean Currents



- The moving continents would alter circulation patterns of the ocean currents.
- A change in ocean densities could also affect the thermohaline circulation.

4. Orbital Changes



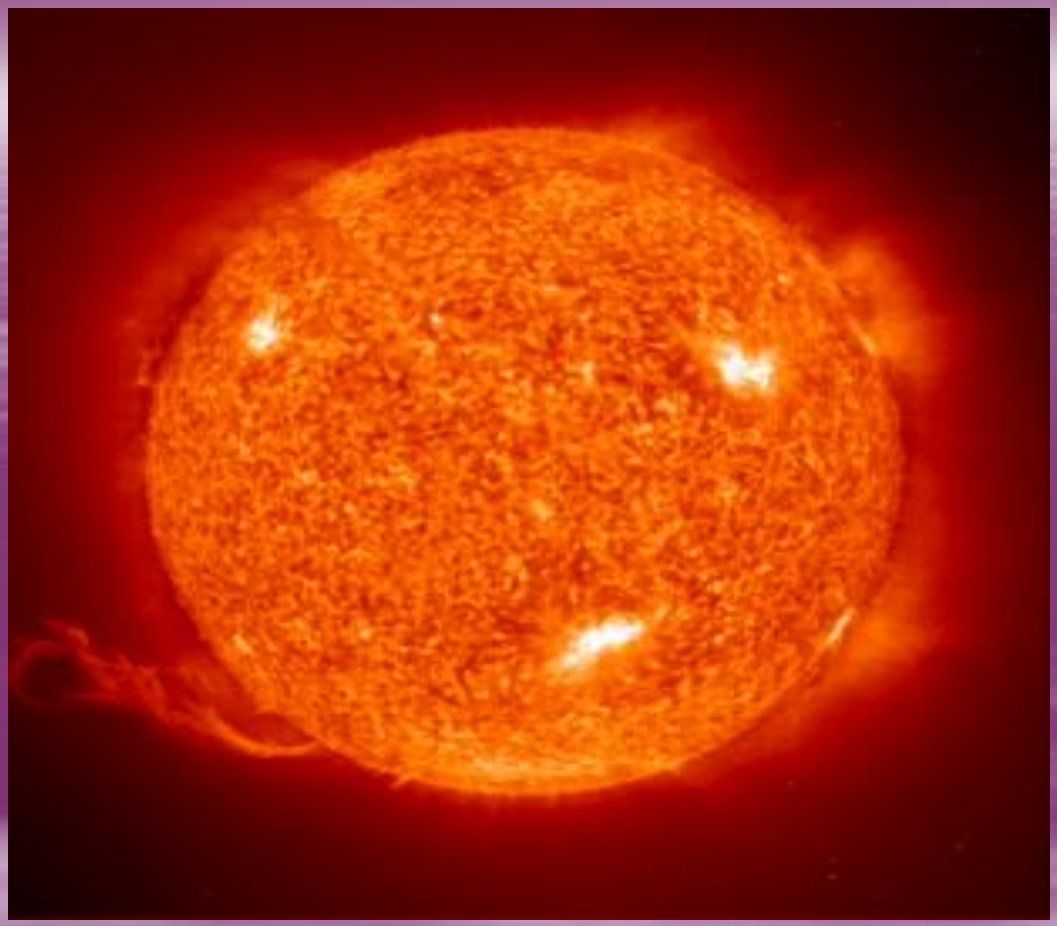
Eccentricity Earth encounters more variation in the energy that it receives from the sun when Earth's orbit is elongated than it does when Earth's orbit is circular.

Tilt The tilt of Earth's axis varies between 22.2° and 24.5°. The greater the tilt angle is, the more solar energy the poles receive.

Precession The wobble of Earth's axis affects the amount of solar radiation that reaches different parts of Earth's surface at different times of the year.

- Changes in the shape of Earth's orbit, tilt, or wobble of its axis could lead to climate changes because of either an increase or reduced amount of sunlight received in area's.

Chapter menu Resources



- Sun’s energy output appears constant, but small changes like solar flares over an extended period of time can lead to warmer climate changes.

5. Solar Variations

Human Causes of Climate Change

- The three main causes of the increase in greenhouse gases observed over the past 250 years have been:

- (1) Fossil fuels,
- (2) Land use, (Deforestation)
- (3) Agriculture.

- What are the types of green house gases?

- 1. Carbon dioxide
- 2. Methane
- 3. Water Vapor
- 4. Ozone

What are the Greenhouse Gases

1. Fossil Fuels

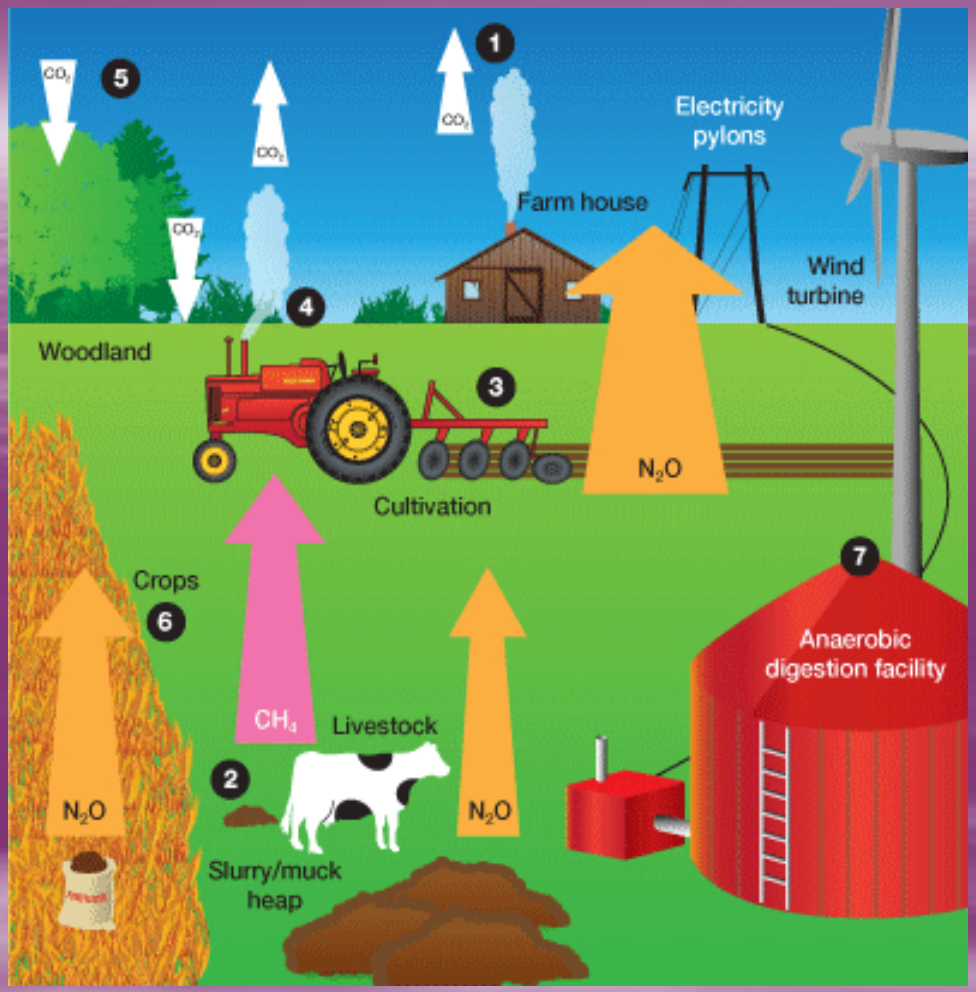
- Pollution from transportation and industry releases carbon dioxide, CO_2, into the atmosphere.
- Increases in CO_2 concentration may lead to an increase in warming (Greenhouse effect).

2. Land Use

- Land use change such as deforestation and desertification, together with use of fossil fuels, present major sources of carbon dioxide and warmer microclimates.

- Cutting down rainforests is estimated to create at least 17% more CO^2 in the atmosphere because trees and plants absorb CO^2 as part of photosynthesis.

Deforestation



- Agriculture creates concerns because:
- Methane emissions from livestock and manure.
- Nitrous oxide emissions from chemical fertilizers.

Agriculture

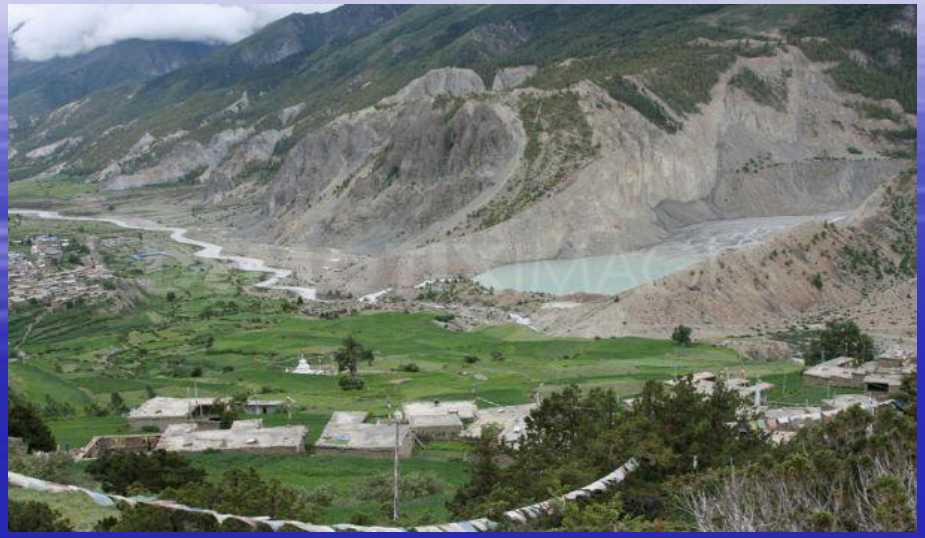
Earth Stops Spinn
Seasons
Earth Spin
Chapter menu
Resources

Check for Understanding

Which has more of an affect on climate change?

human causes or natural causes?

Provide 3-4 pieces of evidence to support your position.



- Some of the most dangerous consequences of climate change are:

- (1) Higher Temperatures
- (2) Changing Landscapes
- (3) Rising Sea Levels
- (4) Stronger Storms
- (5) Heat Related Illness and Disease

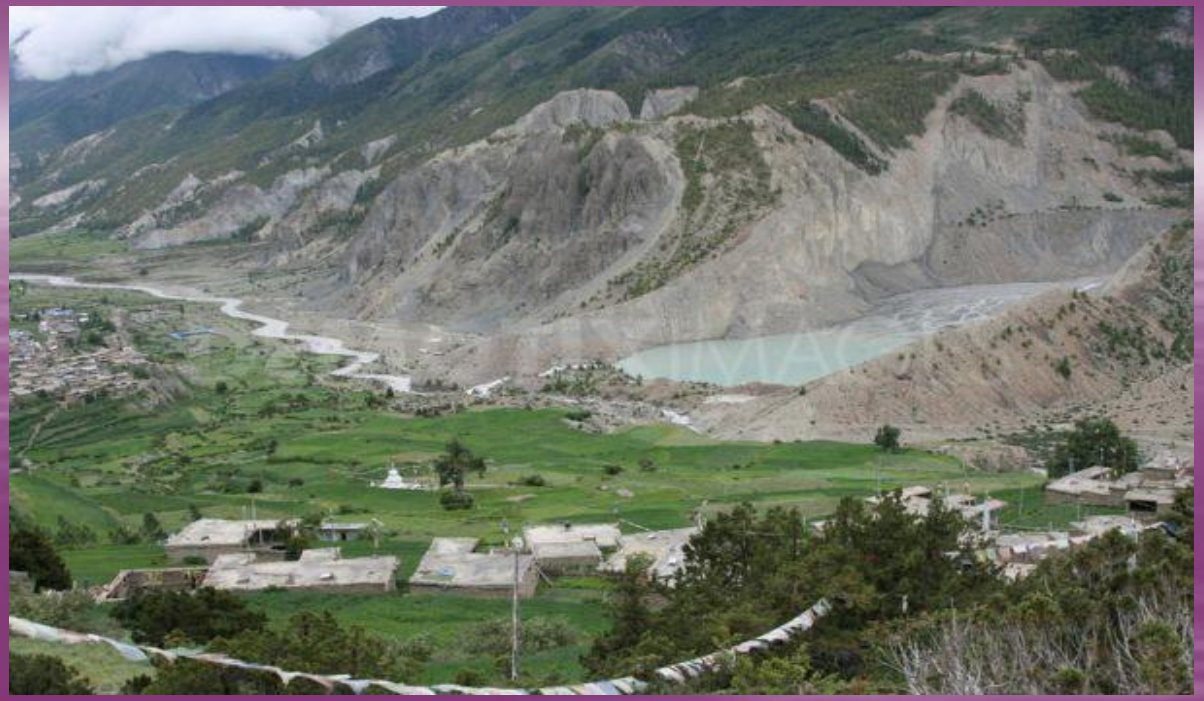
Lesson 7 – Potential Impacts of Climate Change

Climate Change

1. Higher Temperatures

- Temps have constantly increased since the 1990's.
- For example five of the hottest years on record have all occurred since 1997 and the 10 hottest since 1990, including the warmest years on record – 2005 and 2010.

2. Changing Landscapes



- Rising temperatures and changing patterns of rain and snow are forcing trees and plants around the world to move toward polar regions and up mountain slopes.

3. Sea Level Rising

- As the Earth heats up, sea levels rise because:
- Warmer water takes up more room than colder water.

3. Sea Level Rising

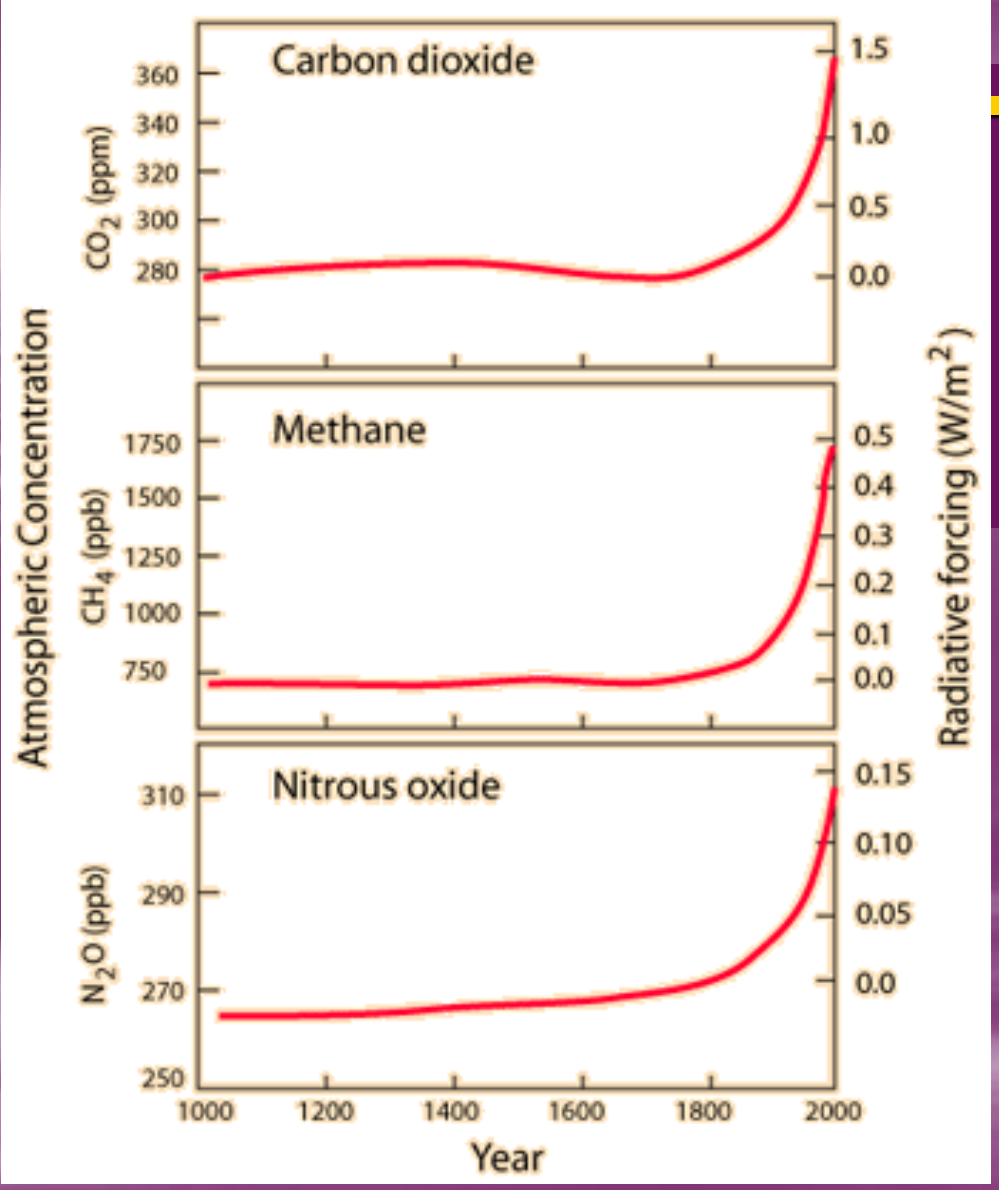
- Melting glaciers compound the problem by dumping even more fresh water into the oceans.
- This changes the coastal city landscapes in low lying areas like Florida and Louisiana.

- Climate change will cause hurricanes and tropical storms to become more intense since hurricanes and tropical storms get their energy from warm water and warm air.

4. Stronger Storms

5. Heat Related Illness and Disease

- Climate change may increase the spread of infectious diseases like:
- Malaria is a parasitic disease that involves high fevers, flu-like symptoms, and anemia.
- Cholera (blame flooding)- is an infection of the small intestine caused by bacteria.

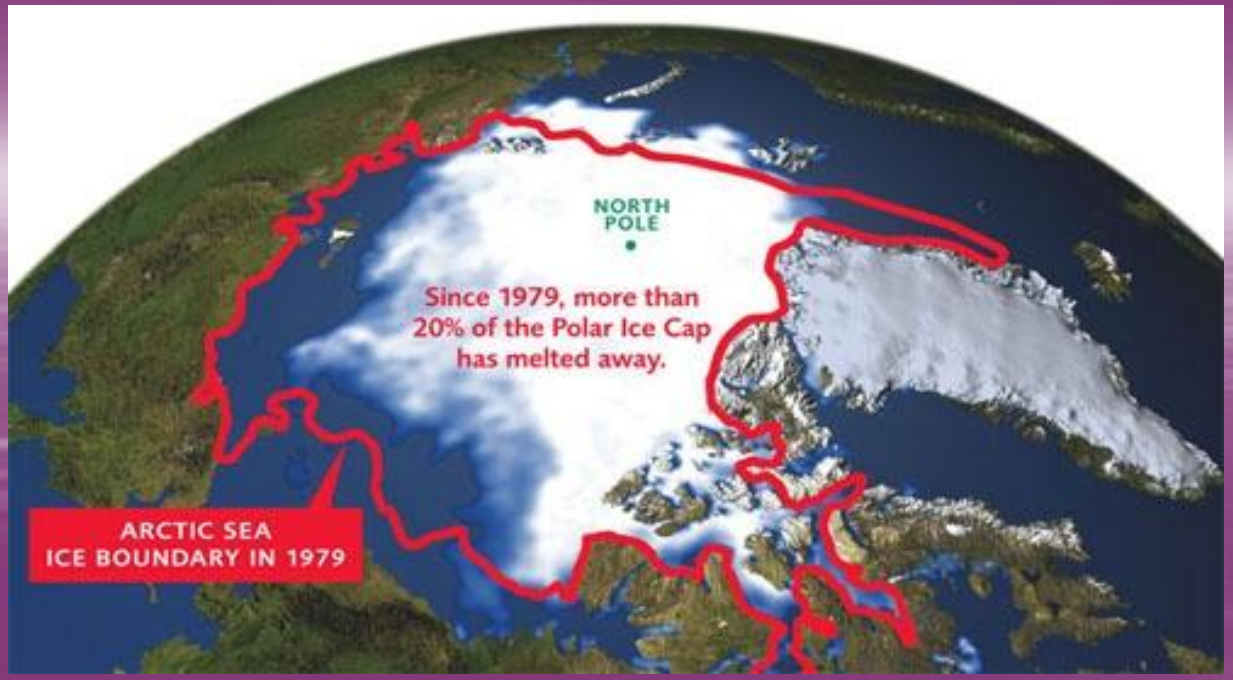


- Current analysis suggests that the combustion of fossil fuels is a major contributor to the increase in the carbon dioxide in our atmosphere.

Increase in the Greenhouse Gases

Chapter menu
Resources

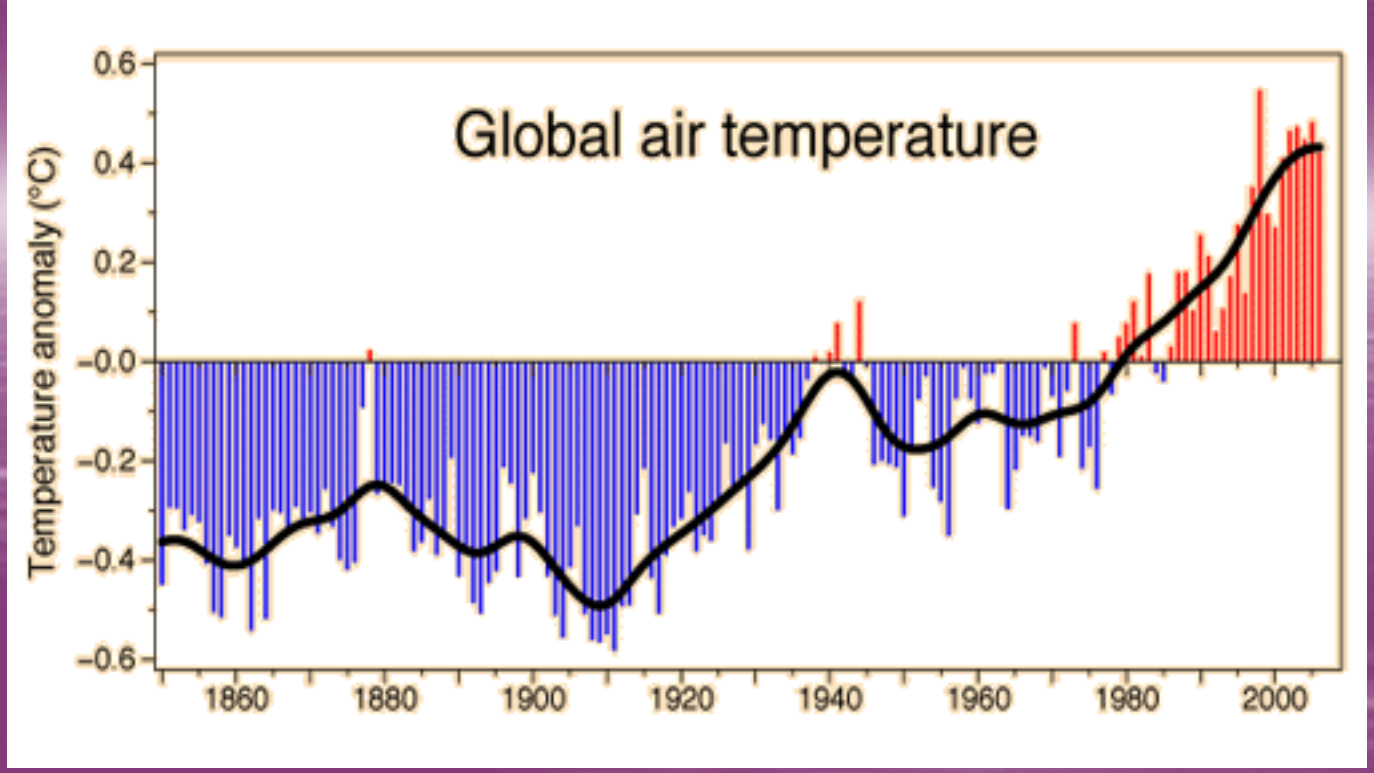
Climate Change



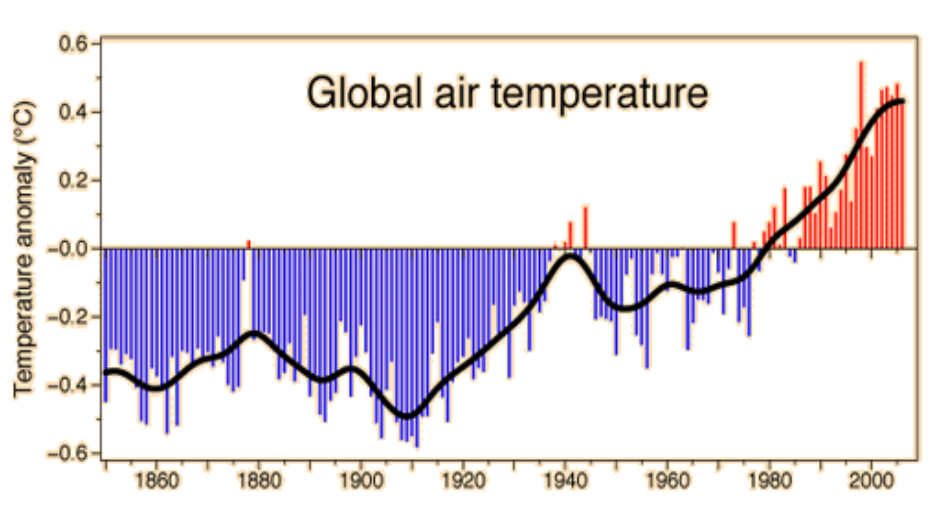
- Because the potential consequences of climate change in terms of loss of snow cover, change in weather patterns, change in the deep thermohaline current, etc., are so great, it is a major societal concern.

Climate Change
Chapter menu
Resources
End of Slide

Climate Change



- Essentially any kind of tabulation you access will tell the same story.
- The temperature has gradually risen over the last 150 years.



- The statistics are not what is disputed.
- The dispute is over how much of an effect humankind is having on the atmosphere.
- How much of this is just nature taking its course.

Climate Change

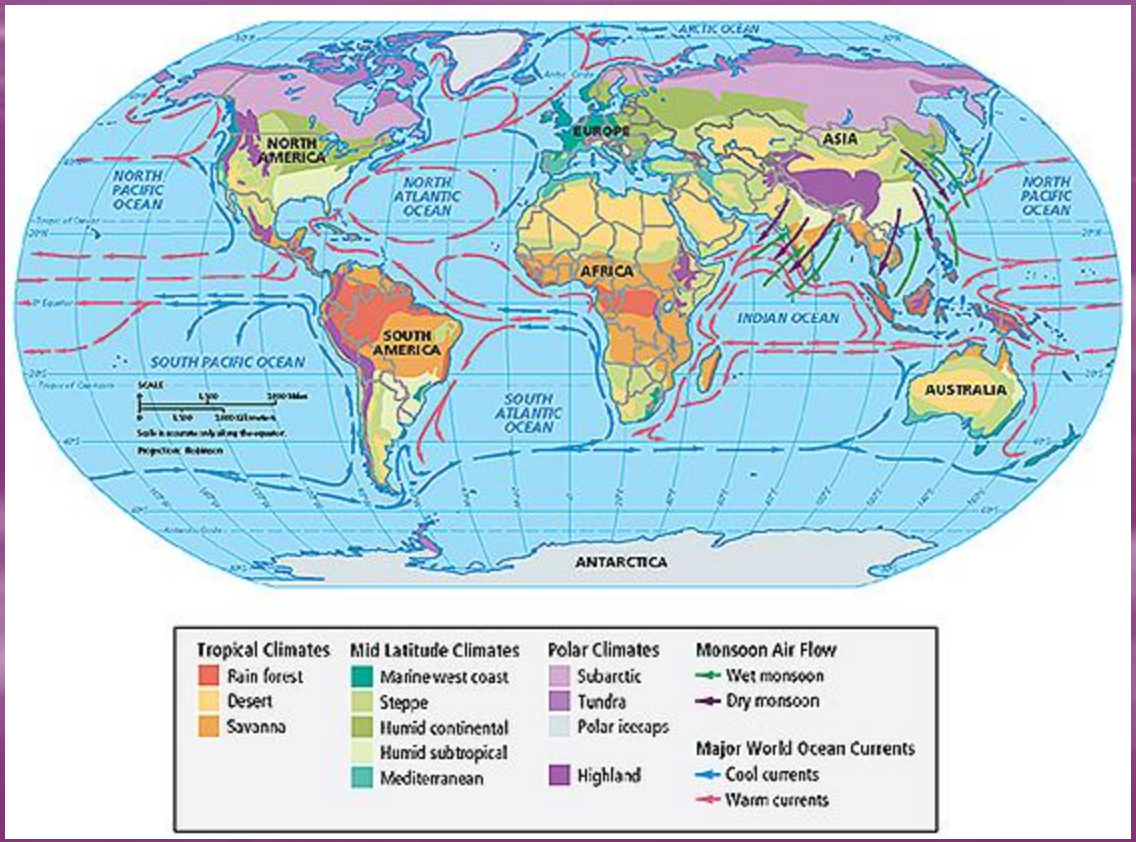
Climate Change

- The potential impact both economically and politically combined with the ambiguities of the science has given rise to many passionate extremes.

Don't Believe
Chapter menu
Resources

Maps in Action

Climates of the World



End Of Slide

Chapter menu

Resources

Check for Understanding

People respond more strongly to threats that are 1._____, 2._____ 3._____ 4._____

What was experienced in September 2014?

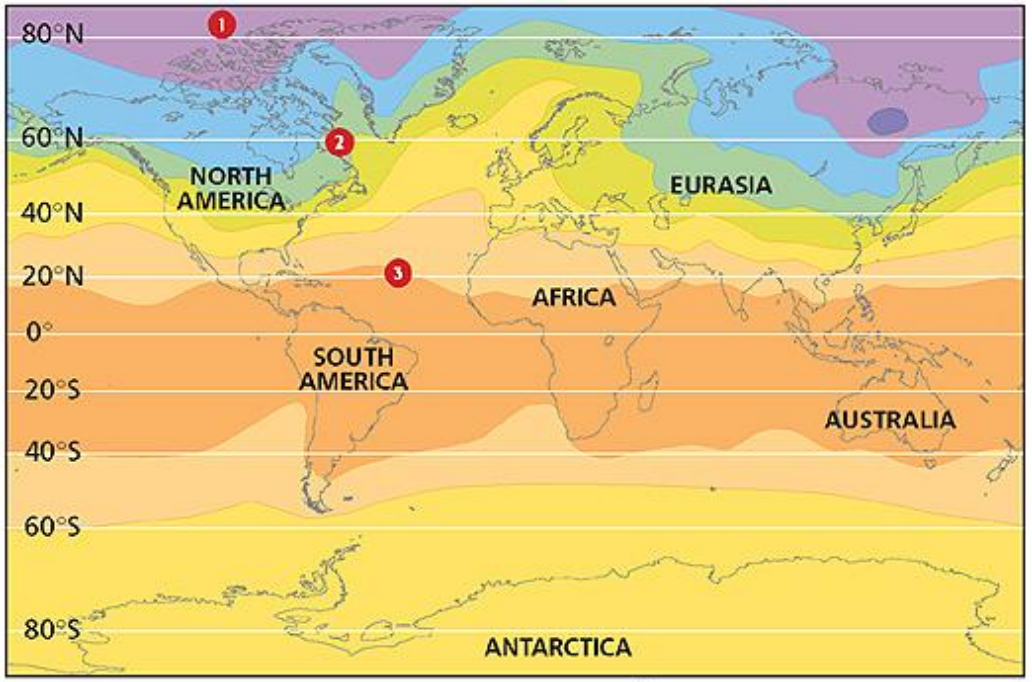
What does climate change involve? Ex: economics (1 of 6)

Average Sea-level Temperature During winter in the Northern Hemisphere

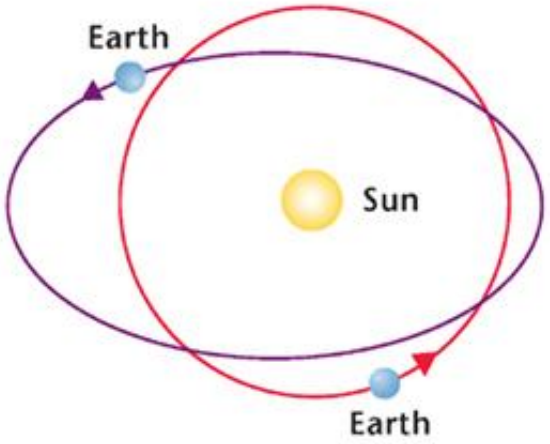
1. In polar regions, the amount of daylight varies from 24 hours of daylight in the summer to 0 hours in the winter. Thus, the annual temperature range is very large, but the daily temperature ranges are very small.

2. At middle latitudes, the sun's rays strike Earth at an angle of less than 90°. The energy of the rays is spread over a large area. Thus, average yearly temperatures at middle latitudes are lower than those at the equator. The lengths of days and nights vary less than they do at the poles. Therefore, the yearly temperature range is large.

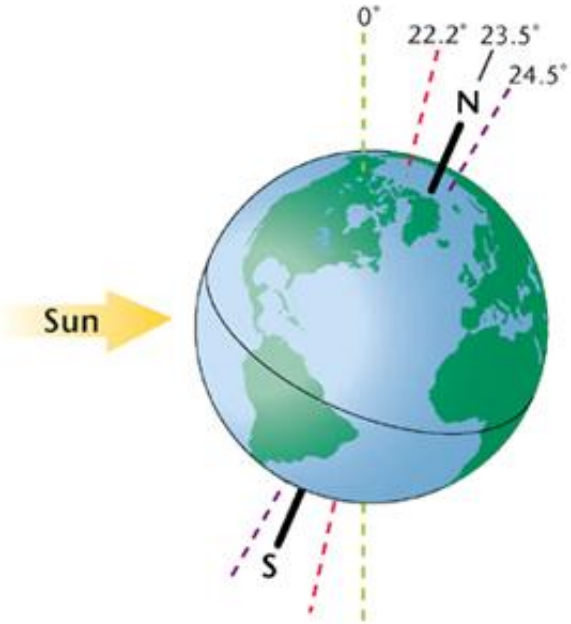
3. At the equator, the sun's rays always strike Earth at a very large angle—nearly 90° for much of the year. In equatorial regions, both days and nights are about 12 hours long throughout the year. So, these regions have steady, high temperatures year-round.



Orbital Changes and Climate



Eccentricity Earth encounters more variation in the energy that it receives from the sun when Earth's orbit is elongated than it does when Earth's orbit is circular.



Tilt The tilt of Earth's axis varies between 22.2° and 24.5°. The greater the tilt angle is, the more solar energy the poles receive.

Precession The wobble of Earth's axis affects the amount of solar radiation that reaches different parts of Earth's surface at different times of the year.

Climates of the World