Ch 13: Atmosphere and Climate Change

13.1 Climate and Climate Change

- Weather is the state of the atmosphere at a particular place at a particular moment.
- Climate is the long-term prevailing weather conditions at a particular place based upon record taken

A. What Factors Determine Climate?

- Climate is determined by a variety of factors
- Most important of these factors is distance from the equator.

B. Latitude

- Latitude is the distance from the equator measured in degrees north or south of the equator.
- The most northerly latitude is North pole at 90° N, and most southerly latitude is the South Pole at 90° S

1. Low Latitudes

- Latitude influences climate because the amount of solar energy an area of earth receives depends on its latitude
- More solar energy falls on areas near the equator
- In regions near the equator the night and day are both about 12 hours long
- Temperatures are high year-round, and there are no summers or winters.

2. High Latitudes

- In regions closer to the poles the amount of energy arriving at the surface is reduced.
- Sunlight hits the earth at an oblique angle and spreads over a larger surface
- Near the poles the sun sets for only a few hours each day in the summer
- The sun rises for only a few hours each day in the winter

C. Atmospheric Circulation

- 1st: Cold air sinks because it is denser than warm air, as cold air sinks it compresses and warms
- 2nd : warm air rises and it expands and cools at is rises
- 3rd : warm air can hold more water vapor than cold air can
- When warm air cools the water vapor may condense into liquid to form rain, snow or fog
- Solar energy heats the ground which warms the air, and cooler air moves into replace it
- The movement of air within the atmosphere is called wind.
- The circulation pattern determines earth's precipitation pattern

1. Global Circulation Patterns

- Cool air normally sinks, but cool air over the equator cannot sink because hot air is rising below the cool air
- As a result the cool air rises and is forced away from the equator.
- At about 30° some of this cool air sinks back down to earth
- Air descending at 30° either moves toward the equator or toward the poles
- Air moving towards the poles warms while it is near earth's surface
- At 60° this air collides with cold air traveling from the poles.
- Cold dry air descends at the poles, which are essentially very cold deserts.

2. Prevailing Winds

- Prevailing winds are winds that blow predominantly in one direction throughout the year
- Because of the rotation of the earth these winds do not blow directly northward or southward.
- Trade winds are belts of prevailing winds that blow most of the time in both hemispheres between 30° and the equator
- Westerlies are produced between 30° and 60°.
- In the northern hemisphere these westerlies are southwest winds
- In the southern hemisphere these westerlies are northwest winds

D. Oceanic Circulation Patterns

- Ocean currents have a great effect on climate because water holds large amounts of heat
- Movement of surface oceans currents is caused mostly by winds and the rotation of the earth
- Surface currents affect the climate in many parts of the world

1. El Nino –Southern Oscillation

- El Nino is the name given to the short term, periodic change in the location of warm and cold water masses.
- During El Nino winds in the western Pacific Ocean (which are normally weak) strengthen and push warm water eastward
- This produces increased rainfall in the southern ½ of the US and in South America
- Causes drought in Indonesia and Australia
- La Nina is where the water in the eastern Pacific Ocean is colder than usual
- it is considered the cold phase
- both El Nino and La Nina are opposite phases of the El Nino-southern oscillation cycle

2. Pacific Decadal Oscillation

- *Pacific Decadal Oscillation (PDO)* is a long-term change in the location of warm and cold water masses in the Pacific Ocean
- This influenced the climate in the northern pacific ocean and north America
- It affects ocean surface temps, air temps, and precipitation patterns.

E. Topography

- Height above sea level (elevation) has a important effect on climate
- Temperature falls by 6°C for every 1000m increase in elevation
- Mountains and mountain ranges influence the distribution of precipitation.

F. Other Influences on Earth's Climate

- Both sun and volcanic eruptions influence earth climate
- *Solar maximum* is when the sun emits an increased amount of ultraviolet (UV) radiation.
- UV radiation produces more ozone , warming the stratosphere
- In large-scale volcanic eruptions, sulfur dioxide gas can reach the upper atmosphere.
- The reaction of sulfur dioxide gas forms a bright layer of haze that reflects enough sunlight.

G. Seasonal Changes in Climate

- G. Seasonal Changes in Climate
- Seasons result from the tilt of the earth's axis
- Because of this tilt the angle at which the sun's rays strike the earth changes as the earth moves around the sun
- During summer in the northern hemisphere the northern hemisphere tilts toward the sun and receives direct sunlight.
- The southern hemisphere tilts always from the sun and receives less direct sunlight.

Stop here and complete the 13.1 active reading worksheet.

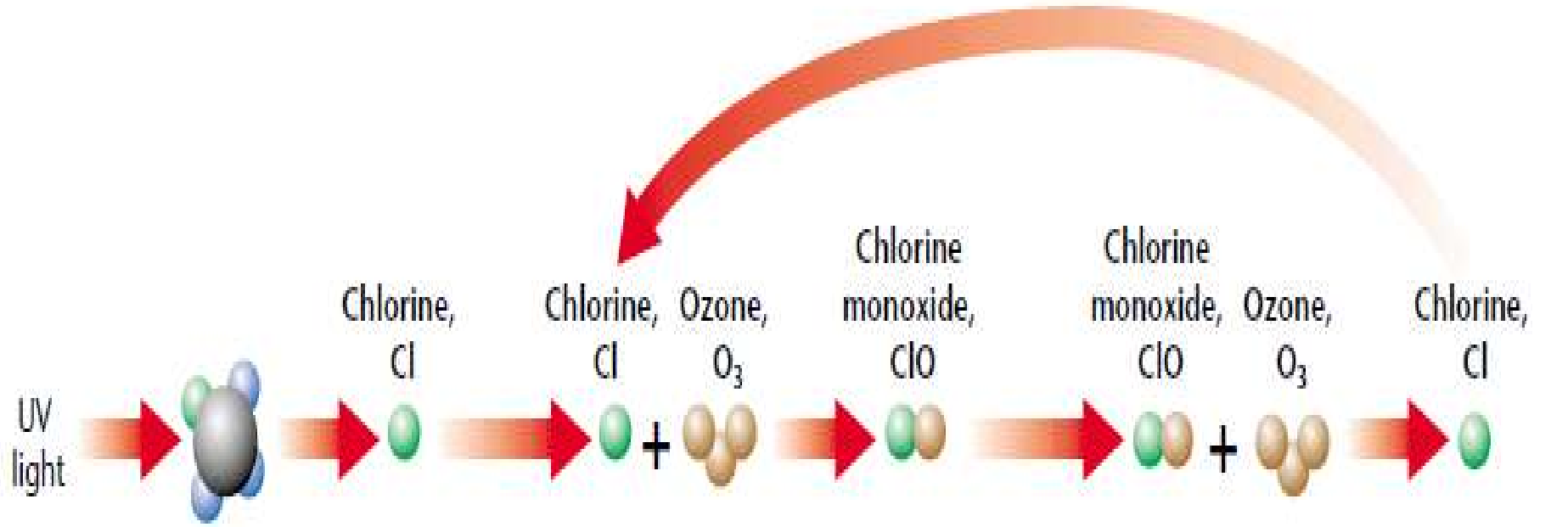
13.2 The Ozone Shield

- Ozone layer is an area in the stratosphere where ozone is highly concentrated
- Ozone is a molecule made of three oxygen atoms
- Ozone absorbs most of the UV light form the sun.
- UV light is harmful to organisms because it can damage the genetic material in cells.

A. Chemicals That Cause Ozone Depletion

- Chlorofluorocarbons (CFCs) are hydrocarbons in which some or all of the hydrogen atoms are replaced by chlorine and fluorine.
- CFC's were used in coolants for refrigerators and air conditioners and in cleaning solvents
- Scientists worry that they might be damaging the ozone layer.
- Once the CFC molecules break apart, parts of the CFC molecules destroy protective ozone
- Scientists have estimated that a single chlorine atom from CFC can destroy 100,000 ozone molecules

How CFC's destroy ozone!



1. UV light causes the CFC to break down, releasing a chlorine atom.
2. The chlorine atom reacts with an ozone molecule to create an oxygen molecule and a chlorine monoxide molecule.
3. The chlorine monoxide molecule then reacts with another ozone molecule, creating two molecules of oxygen and one chlorine atom.

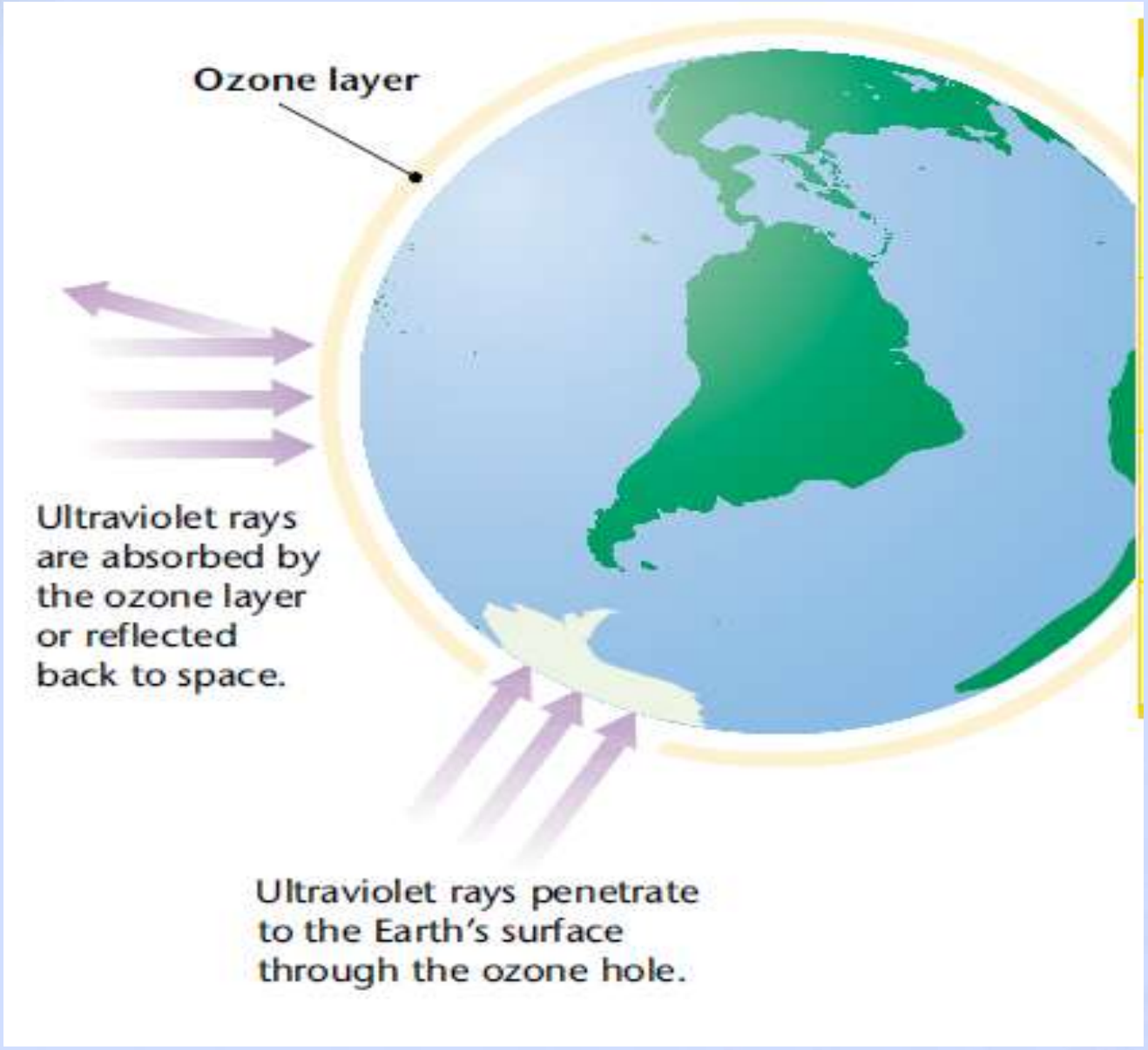
B. The Ozone Hole

- In 1985 a study revealed that the ozone layer above the south pole had thinned by 50-98 percent
- Ozone hole is a thinning of stratospheric ozone that occurs over the poles during the spring
- The concentrations of ozone fluctuates during the year but data showed a growing ozone hole

1. How Does the Ozone Hole Form?

- *Polar vortex* is the strong circulation winds over Antarctica during the dark polar winters
- Polar Stratospheric clouds are high altitude clouds made of water and nitric acid
- On the surface of polar stratospheric clouds the products of CFCs are converted to molecular chlorine
- When the sunlight returns the molecular chlorine is split into two chlorine atoms and rapidly destroys ozone
- Ozone produce by pollution breaks down or combines with other substance before it can reach the stratosphere to replace the ozone being destroyed.

1. How Does the Ozone Hole Form?



2. Effects of Ozone Thinning on Humans

- As the amount of ozone decreases more UV light is able to pass through the atmosphere and reach Earth's surface
- Exposure to UV light makes the body more susceptible to skin cancer

3. Effects of Ozone Thinning on Animals and Plants

- High levels of UV light can kill single-celled organisms call *phytoplankton*
- Loss of phytoplankton could disrupt ocean food chains and reduce fish harvests
- UV light can kill unprotected DNA in eggs of amphibians, increased UV light will kill more eggs
- UV light damages plants by interfering with photosynthesis
- This can result in lower crop yields

Damaging Effects of UV Light	
Humans	• increased incidence of skin cancer • premature aging of the skin • increased incidence of cataracts • weakened immune response
Amphibians	• death of eggs • genetic mutations among survivors • reduction of populations
Marine Life	• death of phytoplankton in surface water • disruption of food chain • reduction in the number of photosynthesizers
Land Plants	• interference with photosynthesis • reduced crop yields

C. Protecting the Ozone Layer

- *Montreal Protocol* is an agreement between nations to agree to sharply limit their production of CFCs
- US pledged to ban all substances that pose a significant danger to the ozone layer by 2000
- The battle to protect the ozone is not over CFC's can remain active for 60-120 years

Stop here and complete the 13.2 active reading worksheet.

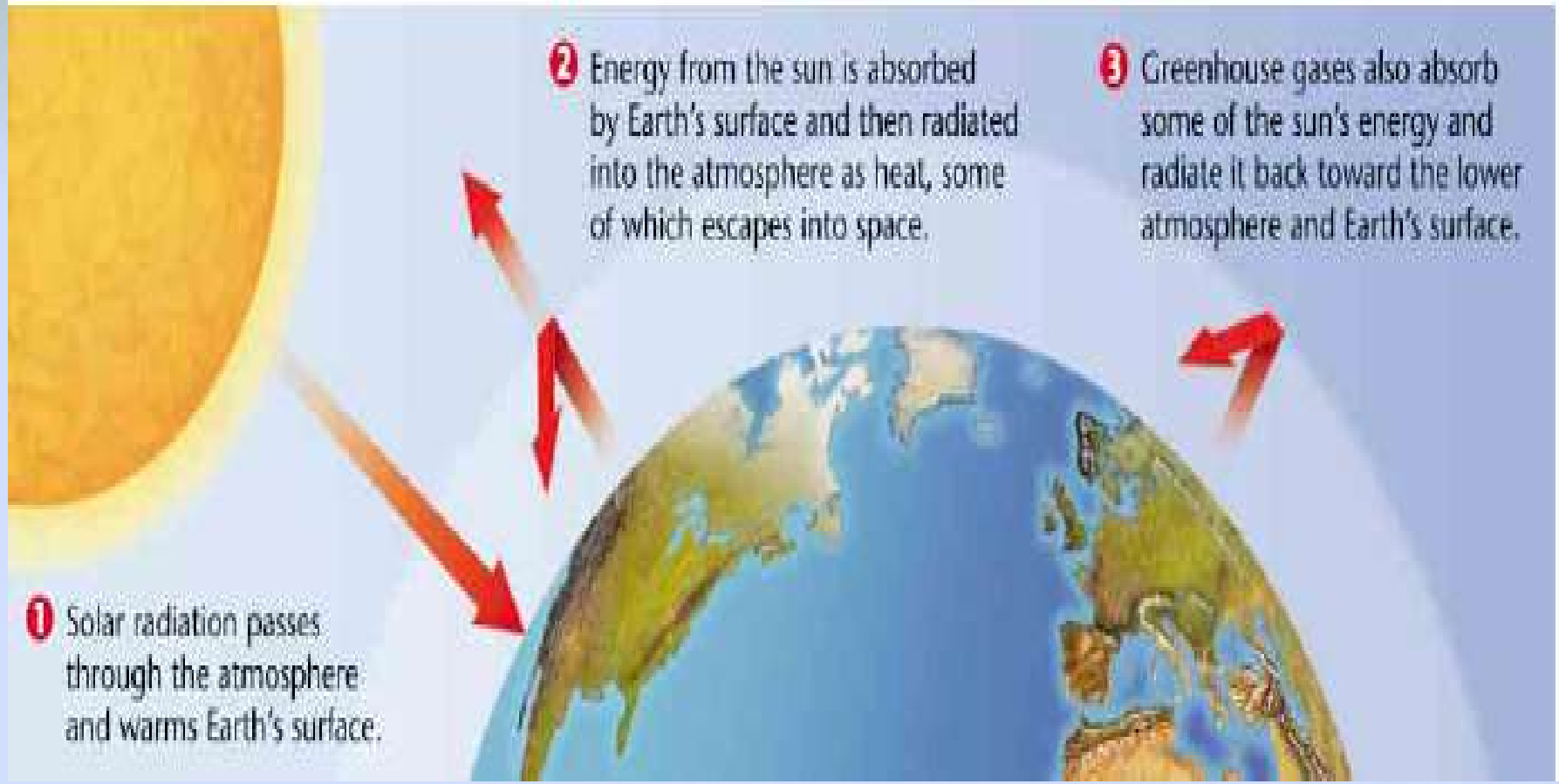
13.3 Global Warming

- The reason a car interior heats up is because the suns energy streams into it through the windows and the carpets and upholstery absorb the light and change it into heat energy
- The heat continues to build up and is trapped inside the car.
- This is similar to what happens in a green house.

A. The Greenhouse Effect

- The earth's atmosphere acts like the glass in a greenhouse
- Heat streams through the atmosphere and heats the earth, some of this heat radiates out into space and the rest of the heat is absorbed by the gasses in the troposphere and warms the air.
- That process is known as the *greenhouse effect.*
- Greenhouse gases are gases in our atmospheres that absorb and radiate heat.
- the major greenhouse gases are water vapor, carbon dioxide, chlorofluorocarbons, methane and nitrous oxide.
- Water vapor and carbon dioxide account for most of the absorption of heat that occurs in the atmosphere.

How the Greenhouse Effect Works



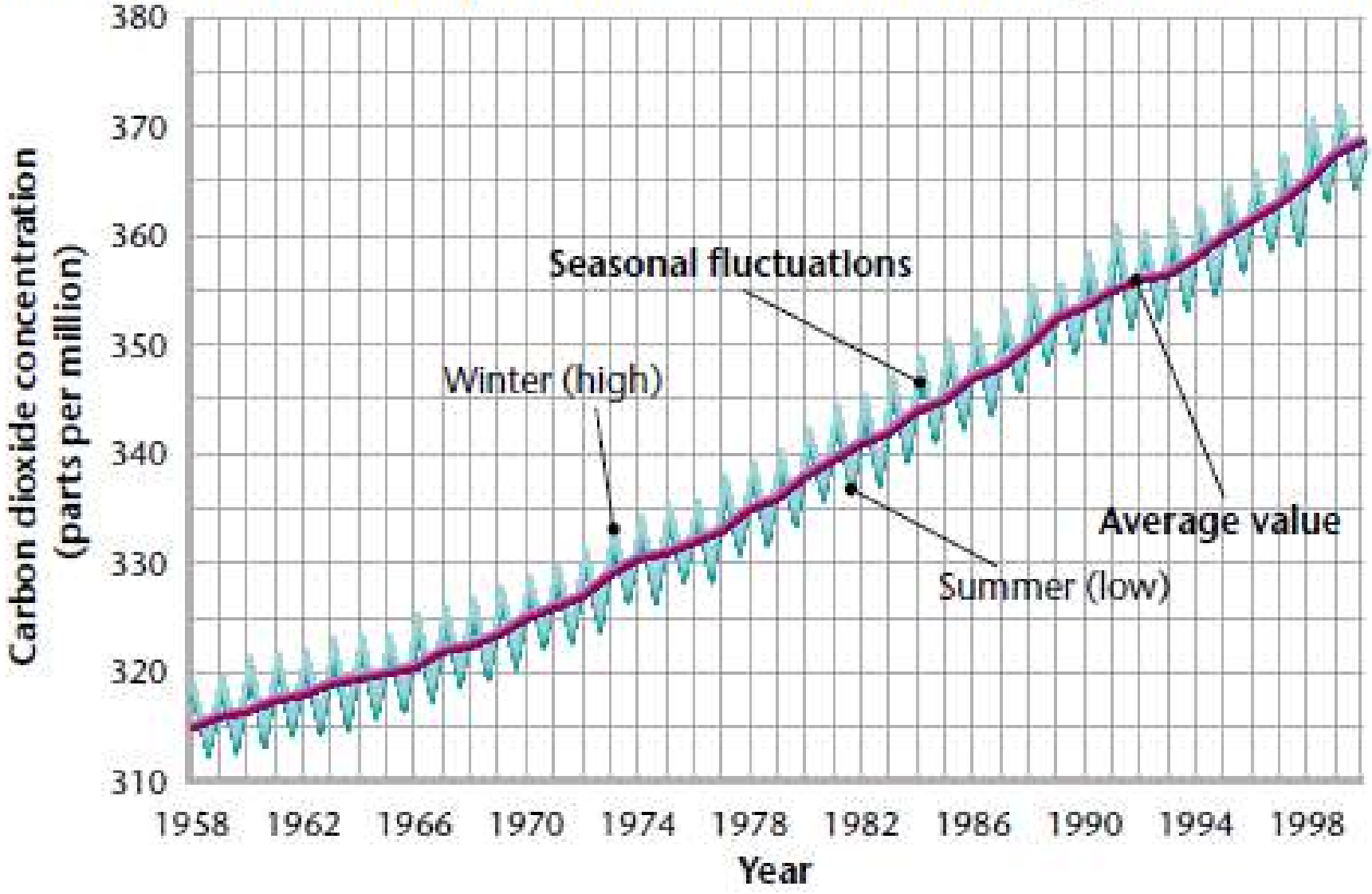
Measuring Carbon Dioxide in the Atmosphere

- 1958 Charles Keeling installed an instrument at the top of a tower on the volcano Mauna Loa in Hawaii.
- This instrument was to measured the CO_2 levels in the air.
- This location was picked because it is far from cities and forests (CO_2 levels vary daily in those areas)
- Most of the CO_2 that is released into the air dissolves in the ocean or is used by plants for photosynthesis.
- During the summer plants use more CO_2 than they release in respiration.
- This causes CO_2 levels in the air to decrease in he summer
- In the winter the dying grasses and fallen leaves decay and release the carbon that was stored in them and as a result the CO_2 levels naturally rise

2. Rising Carbon Dioxide Levels

- After a few years of measuring it was obvious that the CO_2 levels were changing in ways other than just the season fluctuations
- The figure below show that CO_2 level in the atmosphere have increased by 20% in less than 50 years
- This increase is due largely to the burning of fossil fuels
- These measurements show that CO_2 levels in the atmosphere today are higher than they have been for the last 420,000 years, and probably for the last 20 million years.

Increase in Atmospheric Carbon Dioxide, 1958–2000

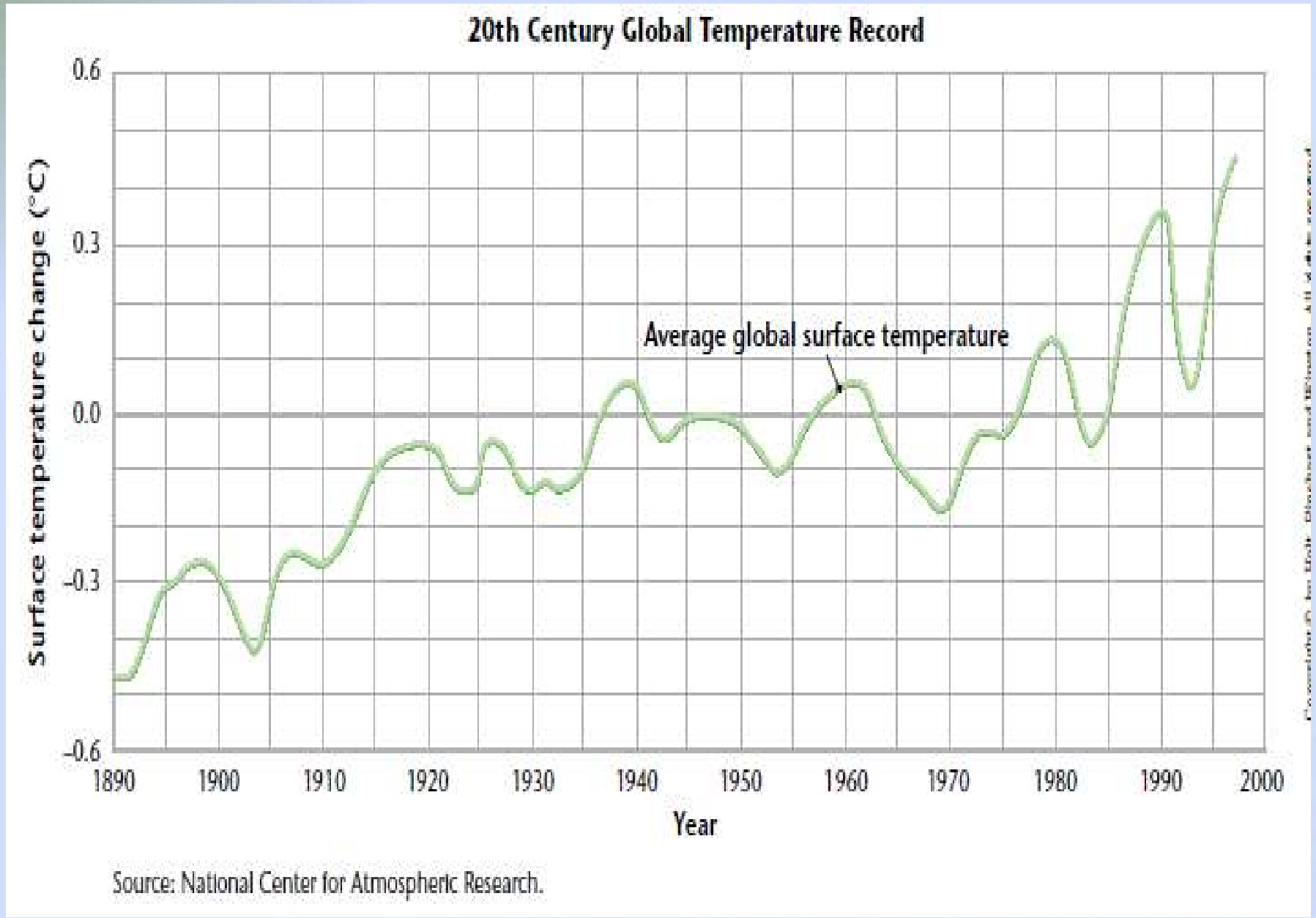


3. Greenhouse Gases and the Earth's Temp.

- Many scientists think that more greenhouse gases in the atmosphere will result in an increase in global temperature
- The comparison of CO_2 levels and the average global temperatures for the past 400,000 years supports this view.
- Today we are releasing more CO_2 gasses than any other greenhouse gas into the atmosphere.
- The CO_2 comes from power plants that burn coal or oil, and from cars
- Also from burning trees in the tropical rain forests to clear the land for farming

B. Global Warming

- The figure below sows that the average temperature at Earth's surface increased during the twentieth century.
- Global warming is the increase in the Earth's surface temperature.
- The temperature is rising at a similar rate to the increase in greenhouse gases in the atmosphere
- Many scientists have hypothesized that the increase in greenhouse gases has caused the increase in temperature.
- But it is not possible to rule out natural climatic variability


20th Century Global Temperature Record
Surface temperature change (°C)
0.6
0.3
0.0
-0.3
-0.6
Average global surface temperature
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
Year
Source: National Center for Atmospheric Research.

1. Modeling Global Warming

- Predictions about future changes in climate are based on computer models
- The models can be used to predict how factors such as temperature and sea level will be affected.
- The programs and models they produce are not always accurate
- Computer models are becoming more reliable, as more data is available and additional variables are include

C. The Consequences of a Warmer Earth

- In North America, tree swallows; Baltimore orioles and robins are nesting about 11 days earlier than they did 50 years ago.
- In Britain 200 species of plants are flowering up to 55 days earlier in the year than they did 40 years ago.
- There is no evidence that these changes are caused by global warming
- But both are strongly influenced by temperature
- Scientists are not sure how quickly the earth will warm or how severe the effects will be
- Possible effects of global warming include changes in weather patterns and rising sea levels
- The effects of a warmer Earth will not be the same everywhere

1. Melting Ice and Rising Sea Levels

- Ice melts as global temperatures increase.
- The melting of ice causes sea levels around the world to rise
- Coastal wetlands and other low-lying areas could be flooded
- Beaches could be extensively eroded and the salinity of bays and estuaries might increase

2. Global Weather Patterns

- If the Earth warms up significantly the surface of the oceans will absorb more heat and make hurricanes and typhoons more common
- Global warming could change the oceans current patterns, like shutting off the Gulf Stream
- Some regions might have more rainfall then normal and other regions might have less.

3. Human Health Problems

- Warmer average global temperatures pose potential threats to humans health
- Greater numbers of heat related deaths could occur
- Trees and flowering plants would flower earlier and for longer causing people with allergies to pollen would suffer from allergies longer
- Warmer temperatures could enable mosquitoes to establish themselves in areas that are too cold for them at the moment.

4. Agriculture

- Agriculture would be most severely impacted by global warming if extreme weather events become more frequent.
- Higher temperatures could result in decreased crop yields
- Demands for irrigation would further deplete aquifers

5. Effects on Plants and Animals

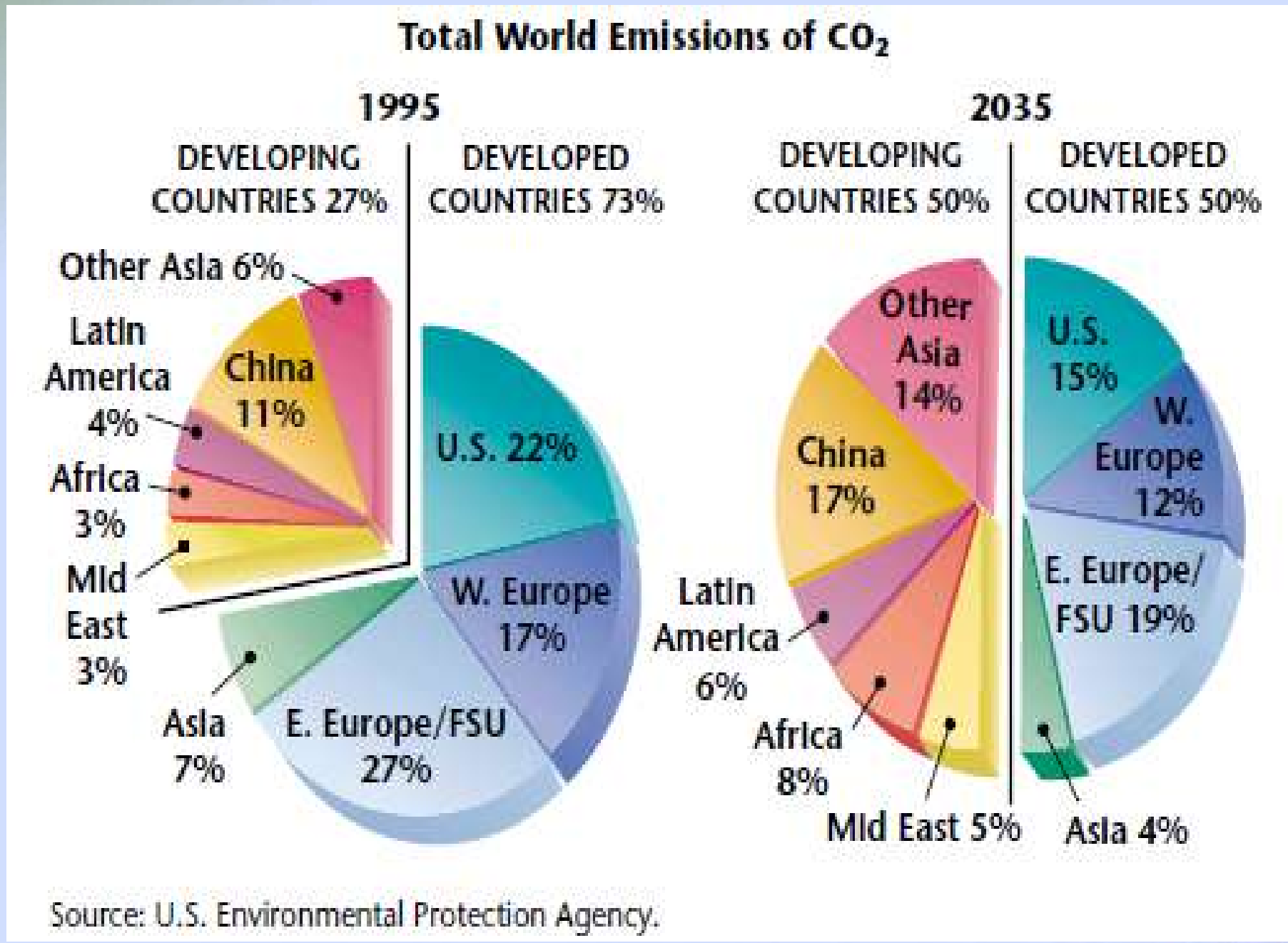
- Climate change could after the range of plants species and the composition of plant communities
- Trees could colonize cooler areas
- Forests could shrink in the warmer part of the range
- There may be a shift in the geographical range of animals
- Warming in surface water of the ocean might cause a reduction of zooplankton (the source of food for many fish)
- Warming in tropical waters may kill the algae that nourish the corals and destroy coral reefs

D. Recent Findings

- The Intergovernmental Panel of Climate Change (IPCC) is a network of leading climatologists from 70 countries
- IPCC issued its Third Assessments Report (TAR) that describes future estimates about the state of the global climate system.
- Some findings include that the average global surface temperature increased by 0.6°C
- Snow cover and ice extend have decreased and the average global sea level has risen
- TAR predicted that human influences will continue to change the composition of the Earth's atmosphere throughout the 21st century.

E. Reducing the Risk

- In 1997 representatives from 160 countries met and set timetables for reducing emissions of greenhouse gasses.
- The Kyoto Protocol requires developed countries to decrease emissions of carbon dioxide and other greenhouse gasses by an average of 5% below the 1990 levels
- The need to slow global warming has been recognized by the global community
- The attempt to slow global warming is made difficult by economic, political, and social factors faced by different countries.


Total World Emissions of CO_2
1995
DEVELOPING COUNTRIES 27%
DEVELOPED COUNTRIES 73%
Other Asia 6%
Latin America 4%
China 11%
Africa 3%
Mid East 3%
Asia 7%
E. Europe/FSU 27%
W. Europe 17%
U.S. 22%
2035
DEVELOPING COUNTRIES 50%
DEVELOPED COUNTRIES 50%
Other Asia 14%
China 17%
Latin America 6%
Africa 8%
Mid East 5%
U.S. 15%
W. Europe 12%
E. Europe/ FSU 19%
Asia 4%
Source: U.S. Environmental Protection Agency.

Stop here and complete the 13.3 Active Reading worksheet.