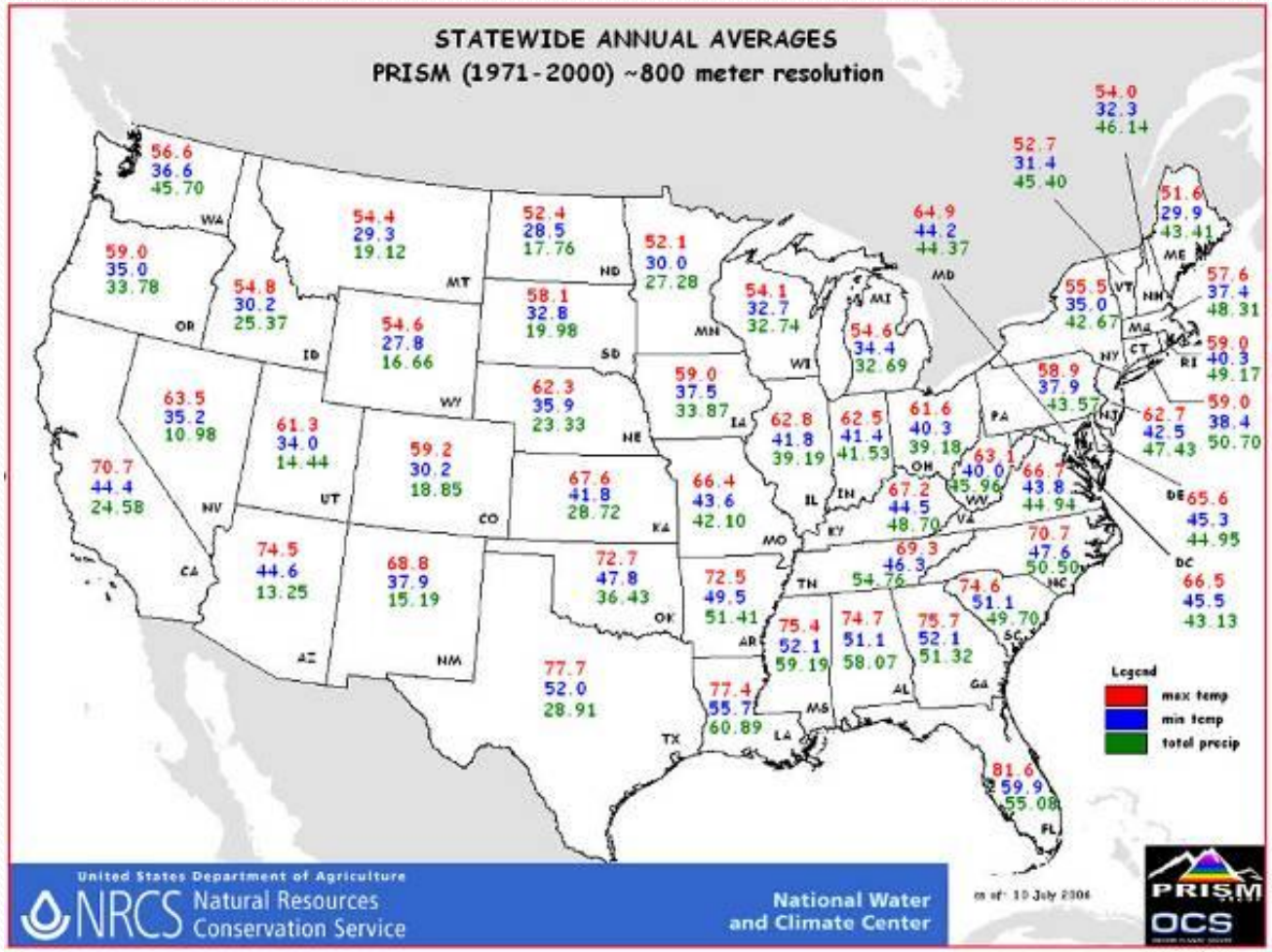
Climate Vs. Weather

- **Climate**
  - Long-term weather patterns of an area
- **Weather**
  - Current state of the troposphere
  - Short term variations

Climate

What is climate?

Climate refers to time and space patterns of precipitation, temperature, and wind. For example, temperature and precipitation differ across the United States.



Climatology

- The study of Earth's climate and the factors that affect past, present, and future climatic changes

Normals

- Standard values for a location
- Average values over a long period of time

Elements of weather and climate

1. Properties that are measured regularly
2. Most important elements
    a. Temperature
    b. Humidity
    c. Cloudiness
    d. Precipitation
    e. Air pressure
    f. Wind speed and direction

Earth's Tilt at Seasonal Change

Less direct sun light causes lower temperatures

More direct sun light causes warmer temperatures

Natural Impacts on Climate

Focus Question: How can you explain the impact of natural climate controls on climate?

Climate

Factors That Affect Climate

I. Atmospheric Circulation

- Global winds are another factor that influences climate because they distribute heat and moisture around Earth.

Factors That Affect Climate

II. Vegetation

- Vegetation can affect both temperature and the precipitation patterns in an area.
- Areas with large amounts of vegetation absorb more sunlight. These areas have low albedo.
- More sunlight causes an increase of transpiration. More oxygen and water vapor are emitted.
- Plants also release particles (pollen) that act as condensation nuclei that form clouds.

III. Topography

- Coastal Regions, areas near water, are warmer in the winter and cooler in the summer
- Mountains play an important role in the amount of precipitation that falls over an area.

IV. Water Bodies

- Large bodies of water such as lakes and oceans have an important effect on the temperature of an area because temperature of the water body influences the temperature or the air above it.

V. Latitude

- As latitude increases, The intensity of solar energy decreases.
- **Tropics**
  - Most solar radiation, generally warm
  - Between Tropics of Capricorn and Cancer
  - The Sun's rays are most intense

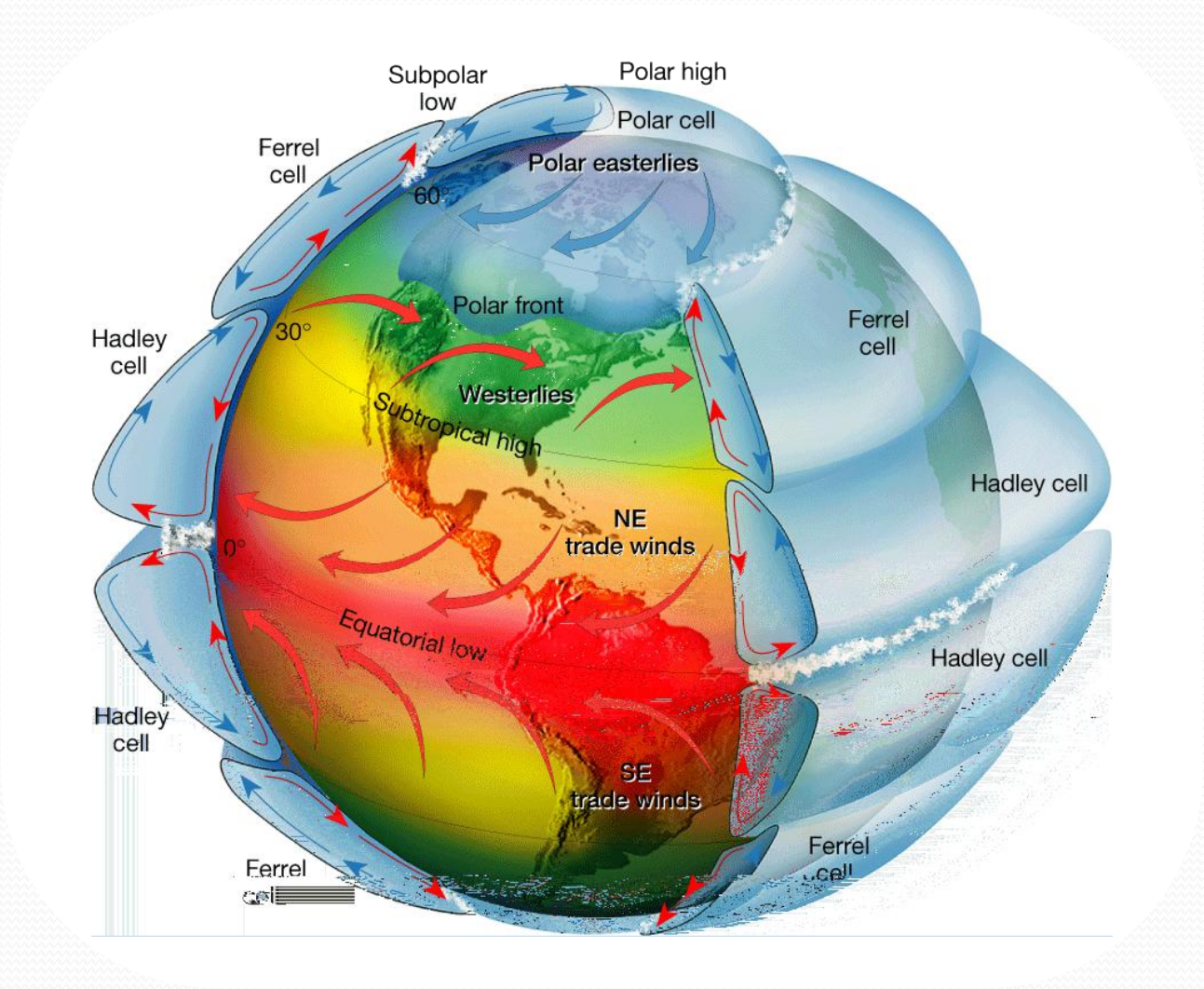
Climate Regions

- **Temperate**
  - Between 23.5 and 66.5 Latitude North and South of the equator
  - Mild temperatures
- **Polar**
  - 66.5 latitude North and South to the Poles
  - Cold Temperatures

VI. Elevation

- Elevation or height above sea level, is another factor that affects climate.
- The higher the elevation the colder the climate
- The elevation of an area determines the amount of precipitation that falls

Climate
Global Winds and Pressure Cells



World Climates

Focus Question

How is the Köeppen climate classification used to describe the world's five major climate groups?

What should I learn?

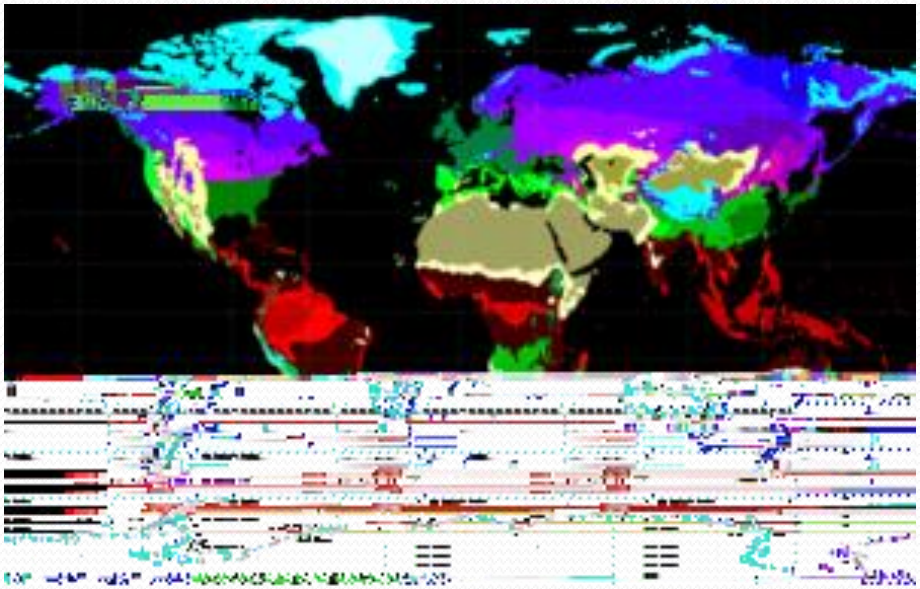
- What is the Köppen climate classification system?
- What are humid tropical climates?
- Contrast the different types of humid mid-latitude climates.
- What are the characteristics of dry climates?
- What are the characteristics of polar climates?
- How do highland climates compare with nearby lowlands?

World Climates

- The **Köppen climate classification system** uses mean monthly and annual values of temperature and precipitation to classify climates.

Koeppen Classification System

- Classified based on temperature and amount of precipitation
  - Tropical
  - Dry
  - Mild
  - Continental
  - Polar



World Climates

- **Humid tropical climates** are without winters. Every month in such a climate has a mean temperature above 18^{o}C. The amount of precipitation can exceed 200 cm per year. There are 2 types of humid tropical climates: Wet Tropical climates and tropical wet and dry climates.

I. Wet Tropical

- **Wet tropical climates** have high temperatures and much annual precipitation.

An example is a rainforest

- Sun's intensity consistently high
- Located on either side of the equator
- Humid unstable air

World Climates

II. Tropical Wet and Dry

- **Tropical wet and dry climates** are climates that transition between the wet tropics and the subtropical steppes.
- Temperature and total precipitation is similar to wet tropical but there are distinct periods of low precipitation.

African Savanna

Tropical grasslands with drought resistant trees

World Climates

- Climates with mild winters have an average temperature in the coldest month that is below 18°C but above -3°C.
- Climates with severe winters have an average temperature in the coldest month that is below -3°C.

World Climates

Humid Mid-Latitude with Mild Winters

- A **humid subtropical climate** is generally located on the eastern side of a continent between latitudes 25º to 40º and is characterized by hot, sultry summers and cool winters. The greatest rainfall is in the months of May, June, July and August.

- A **marine west coast climate** is found on windward coasts from latitudes 40° to 65° and is dominated by maritime air masses. Winters are mild, and summers are cool. This climate is found in a narrow belt in the northern most part of California to southern Alaska.

Humid Mid-Latitude with severe winters

- There are 2 types of this kind of climate Humid Continental climate and subartic climate
- Subartic climate is south of the tundra
- Winters are long and extremely cold
- An example is Russia

World Climates

- A dry climate is one in which the yearly precipitation is not as great as the potential loss of water by evaporation.
  - **Arid or Desert**
    - Great Basin, rain shadow deserts
    - Temperature range 57ºC to 1.7ºC
  - **Semi-Arid – Steppe**
    - Transition zone surrounding desert and separates from humid climates

World Climates

- Humid Mid-Latitude With Mild Winters

- A **dry-summer subtropical climate** is a climate located on the west sides of continents between 30° and 45° latitude. It is the only humid climate with a strong winter precipitation maximum. This climate is found only in California.

World Climates

- Polar climates are those in which the mean temperature of the warmest month is below 10°C.
- Nearly always night
- Extremely cold
- Very little precipitation
- Evaporation is very limited
- Tundra (treeless region)
- Ice cap

An Ice Cap Climate Is a Polar Climate


CLIMATE
CHANGE

What is climate change?

Climate change occurs when the patterns change in time (e.g., winter months get warmer) and space (e.g., monsoon rains occur further south).

Suppose winter in Pennsylvania began to look like winter in Florida?

Long-Term Climatic Change

- Climates change over extremely long periods of time

- Ice Ages – Periods of extensive glacial coverage
  - Most recent ended 10,000 years ago
  - Temperatures dropped 5°C

Long-Term Climate Change

- Volcanic Eruptions
  - Reduction incoming solar radiation
  - Inject large amounts of dust and sulphur dioxide gas into the stratosphere that scatter incoming solar radiation.
  - Studies indicate a global cooling of 0.3%C lasting 1 to 2 years.
  - Incoming solar radiation reduction can be offset by an increase in diffuse radiation and by the absorption of outgoing terrestrial radiation (the greenhouse effect).

Short-Term Weather Change

- Caused by regular variations in daylight, temperature, and weather patterns
- Volcanic eruptions inject dust and gases into the lower atmosphere.
- Examples:
  - Seasons
  - El Nino (Warm ocean current)

Why should we be interested in climate change?

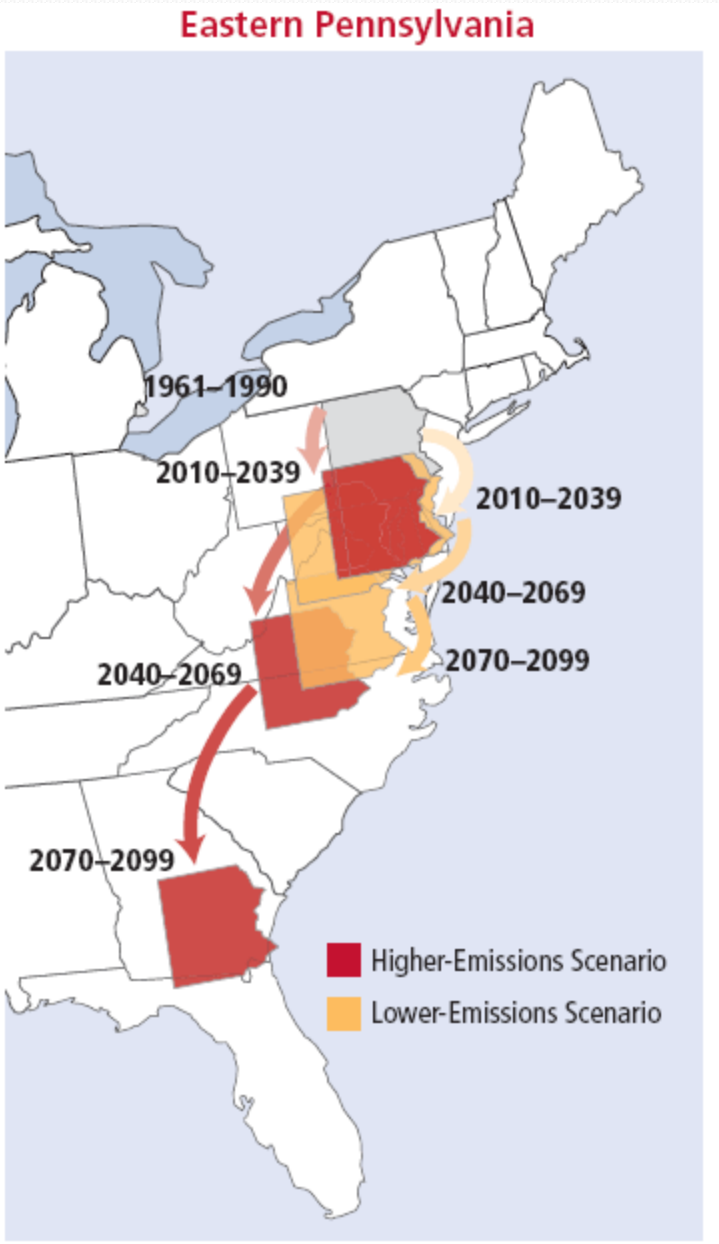
• Climate determines the type and location of human-managed ecosystems, such as agricultural farmlands.
• Climate affects the weathering of rock, the type of soil that forms, and the rate of soil formation.

Why should we be interested in climate change?

- Climate helps to determine the quantity and quality of water available for human use.
- Climate determines the severity of droughts, storms, and floods.

Why should we be interested in climate change?

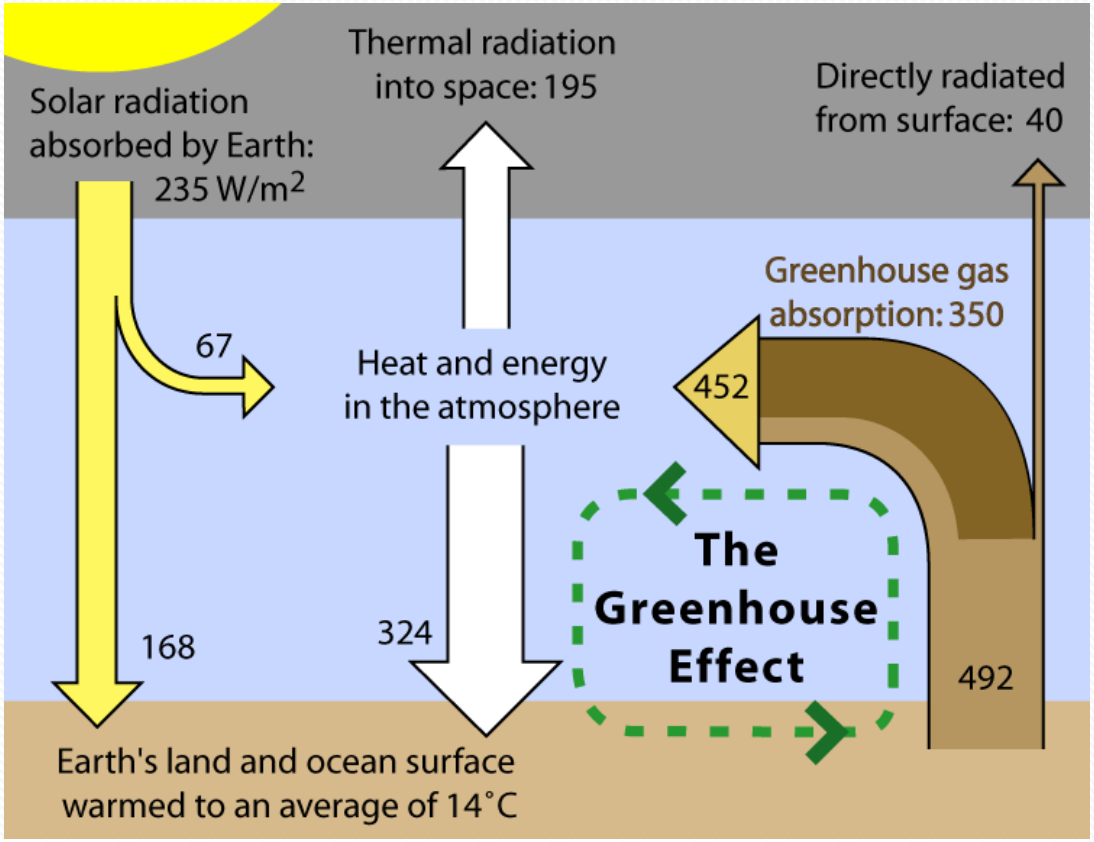
Climate largely determines the nature and locations of <u>biomes</u> (major terrestrial ecosystems, defined based on their plant communities).



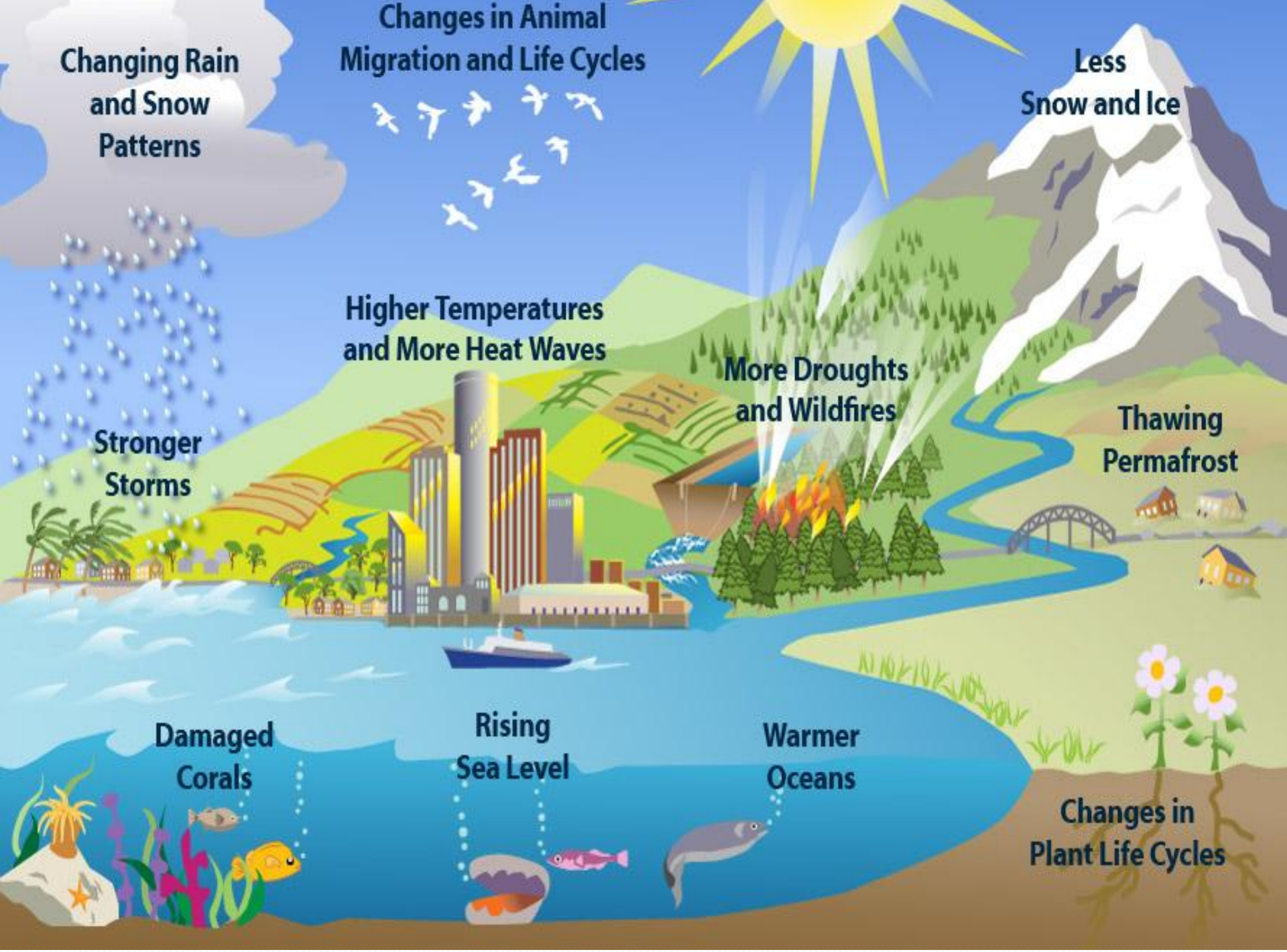
Example: A prediction of climate change for eastern PA. By the end of this century Philadelphia, PA, could have the climate that Savanna, GA, has now.

CO_2 and energy in the atmosphere

- The Earth's surface absorbs solar radiation, and reradiates it as heat.
- CO_2 and other greenhouse gases (GHG) reduce the rate at which this heat can escape into space.
- The more GHG, the higher the global temperature.



- This role of CO_2 and other GHG has been understood for over a century.


Changing Rain and Snow Patterns
Changes in Animal Migration and Life Cycles
Less Snow and Ice
Higher Temperatures and More Heat Waves
More Droughts and Wildfires
Thawing Permafrost
Stronger Storms
Damaged Corals
Rising Sea Level
Warmer Oceans
Changes in Plant Life Cycles

How Does the Burning of Fossil Fuels Affect The Climate?

- When fossil fuels burned energy and gases CO_2 are released.
- Even though only a tiny amount of the gases in Earth's atmosphere are greenhouse gases, they have a huge effect on climate.
- There are several different types of greenhouse gases. The major ones are carbon dioxide, water vapor, methane, and nitrous oxide.

How Does the Burning of Fossil Fuels Affect The Climate?

- All of these have molecules with three or more atoms. The atoms are held together loosely enough that they vibrate when they absorb heat.
- Eventually, the vibrating molecule will release the radiation. The radiation will likely be absorbed by another greenhouse gas molecule.
- This process, which keeps heat near the Earth's surface, is called the greenhouse effect.

Impact of Burning Fossil Fuels

- Adds CO_2 to the atmosphere
- Increasing amounts of CO_2, increases the atmosphere's capacity to absorb more heat radiated from the Earth surfaces.
- The atmosphere temperature increases, causing an increase in the rate of surface water evaporation
- The higher atmosphere temperature causes surface temperatures to increase.

- Nitrogen oxides are produced by the burning of fossil fuels, the use of organic and chemical fertilizers and industrial processes.
- Methane gas is another greenhouse gas that has increased in the atmosphere due to cattle ranching, waste disposal in landfills and the production and distribution of natural gas.

How Does Deforestation Affect the Climate?

- source of carbon emissions
- forest soak up carbon dioxide
- Rainforest trees draw up huge amounts of water from the soil and release most of it into the atmosphere. providing more water to the clouds to be rained back on the forest.
- Evaporation also helps keep the forested landscape cool.
- Large-scale forest loss could dry out the local climate so much that it would be difficult or impossible for the forests to grow back.

How Do Changes in The Ozone Layer Affect Climate

- Changes in the ozone layer have been linked to observed shifts in seasonal surface winds over the Southern Hemisphere, contributing to the Antarctic Peninsula warming and the high plateau cooling.
- Climate change alters the atmosphere's temperature and circulation patterns, which in turn affect the processes that deplete the ozone layer.

Climate Changes

I. Volcanic Eruptions

- The presence of volcanic aerosols (ash, dust, and sulfur-based aerosols) in the air increases the amount of solar radiation that is reflected back into space. This causes Earth's lower atmosphere to cool.

II. Ocean Circulation

- Changes in ocean circulation also can result in short-term climate fluctuations.

Climate Changes

III. Solar Activity

- When the sun is most active, it contains dark blemishes called sunspots. The formation of sunspots appears to correspond with warm periods in Europe and North America.

IV. Earth Motions

- Geographic changes in Earth's land and water bodies cause changes in climate.
- Changes in the shape of Earth's orbit and the tilt of Earth on its axis are other Earth motions that affect global climates.

Climate Changes

V. The Greenhouse Effect

- The **greenhouse effect** is a natural warming of both Earth's lower atmosphere and Earth's surface from solar radiation being absorbed and emitted by the atmosphere.

VI. Global Warming

- As a result of increased levels of carbon dioxide and other greenhouse gases, global temperatures have increased. This increase is called **global warming**.

http://science.howstuffworks.com/environmental/2261-how-greenhouse-gases-work-video.htm

Focus Question:

How do human activities influences global climate change

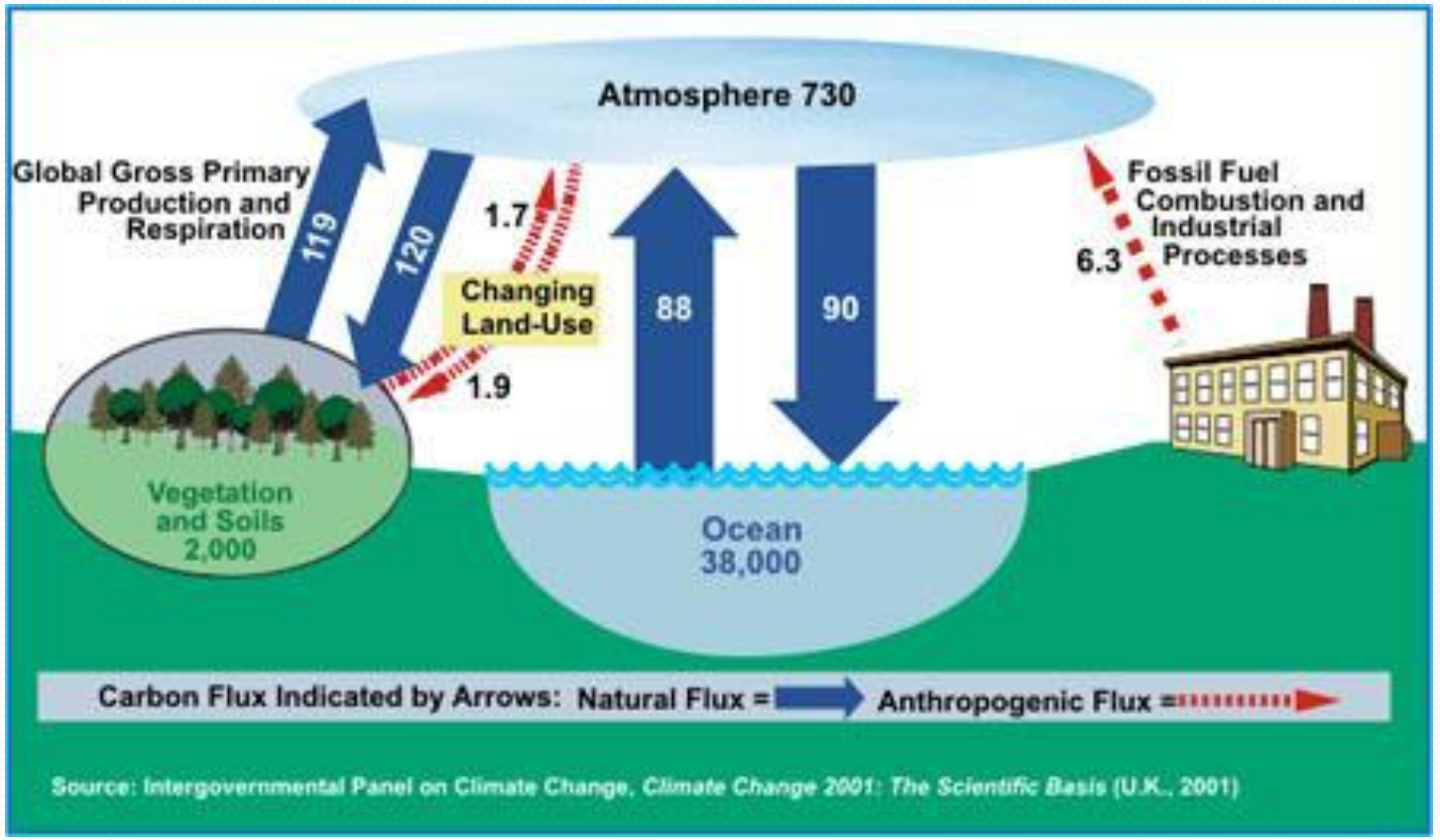
We humans are thought to be the main cause of global warming and climate change……..

but we still have the chance to do something about it.

Is all of the human-caused CO_2 in the atmosphere?

- Only about 50% of the increased CO_2 stays in the atmosphere.

- The rest is absorbed by the oceans and other sinks.



Human Activities Cause Climate Change

Cause changes in Earth's atmosphere in the amounts of greenhouse gases, aerosols (small particles), and cloudiness.

- *The largest known contribution comes from the burning of fossil fuels, which releases carbon dioxide gas to the atmosphere.*
- *Greenhouse gases and aerosols affect climate by altering incoming solar radiation and out-going infrared (thermal) radiation that are part of Earth's energy balance.*
- *Changing the atmospheric abundance or properties of these gases and particles can lead to a warming or cooling of the climate system.*
- *Since the start of the industrial era (about 1750), the overall effect of human activities on climate has been a warming influence.*
- *The human impact on climate during this era greatly exceeds that due to known changes in natural processes, such as solar changes and volcanic eruptions.*

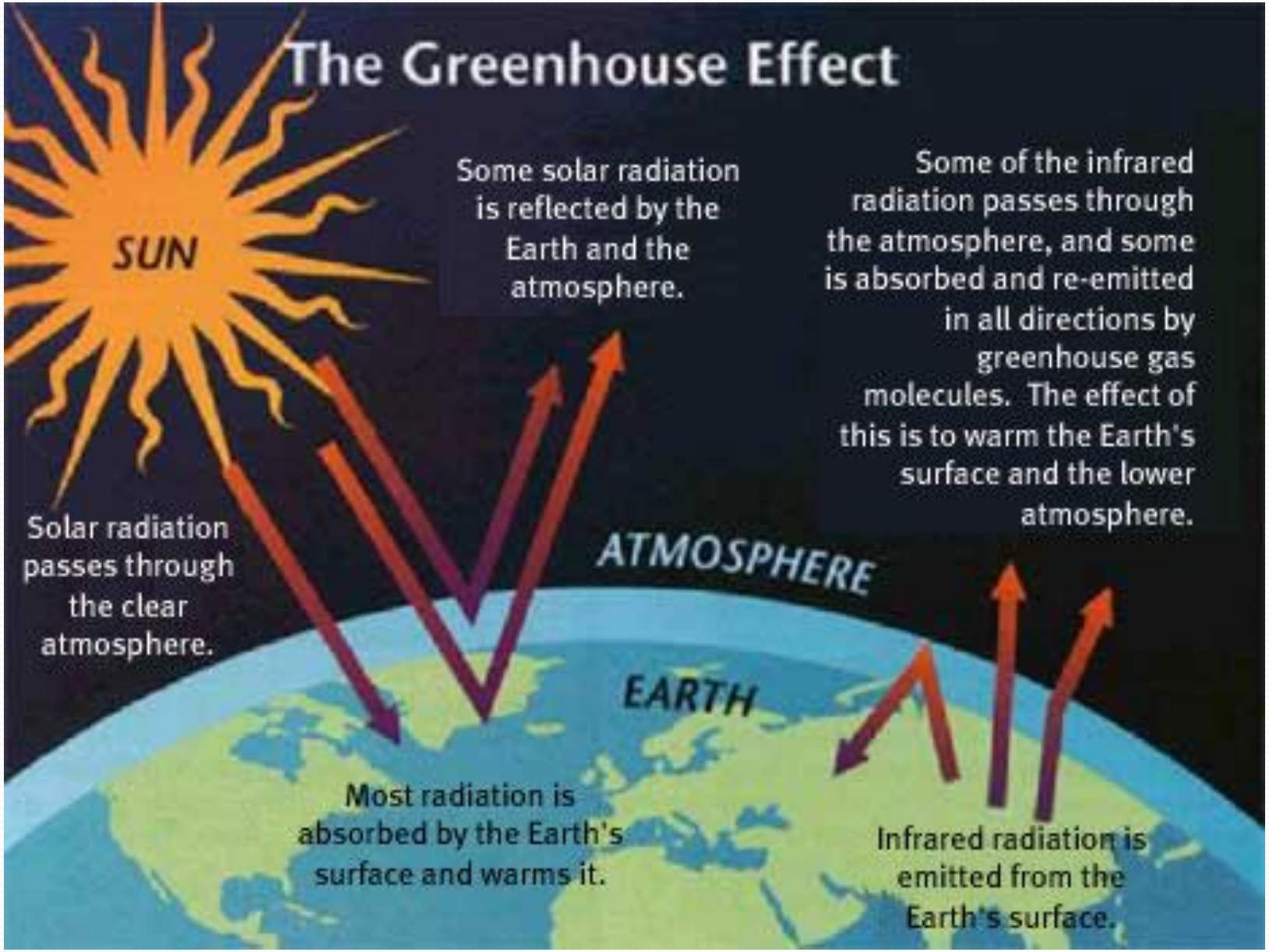
* The sunlight increases the temperature of the surface of the Earth which emits long-wave radiation.
- The greenhouse gases which include carbon dioxide, methane, oxides of nitrogen and sulfur dioxide absorb some of the long-wave radiation preventing from radiating directly into outer space.
- The absorbed long-waves cause the increase in the Earth's temperature.

Greenhouse Effect

- The greenhouse effect is appropriately named due to the fact that it functions in much the same way as a greenhouse.
- The sun emits short wavelengths that can pass through the atmosphere for the most part.

Greenhouse Effect

- Without the greenhouse effect, much of Earth's heat energy would be lost to outer space.
- Earth's average temperature would be about 33°C cooler than it is now – freezing!
- The greenhouse effect has helped Earth thrive as a planet.
- However, recently we have seen a significant increase in levels of carbon dioxide in the atmosphere. We are watching to see if the global heat budget is getting out of balance.


The Greenhouse Effect
SUN
Some solar radiation is reflected by the Earth and the atmosphere.
Some of the infrared radiation passes through the atmosphere, and some is absorbed and re-emitted in all directions by greenhouse gas molecules. The effect of this is to warm the Earth's surface and the lower atmosphere.
Solar radiation passes through the clear atmosphere.
ATMOSPHERE
EARTH
Most radiation is absorbed by the Earth's surface and warms it.
Infrared radiation is emitted from the Earth's surface.

Greenhouse Gases

Water Vapor H_2O From evaporation of surface water

Carbon Dioxide CO_2 From burning of fossil fuels and volcanic eruptions

Methane CH_3 From the decomposition of organic matter.

Ozone O_3 From the bakeries, paint shops, dry cleaners, aircraft, locomotives, cars, trucks, buses, forest fires, vegetation

Nitrous Oxide N_2O From burning coal to produce electricity, synthetic farm fertilizers and pesticides and decomposition of livestock manure and urine.

These gasses are

- **large molecules**
- **absorb energy radiated from Earth's surface**
- **emit energy**

- All of the greenhouse gases are less transparent to heat than light.
- This means the increased gases in our atmosphere are trapping more and more heat each year.
- This is intensifying the Earth's natural greenhouse effect and global climate change is occurring.

Affect of Methane

- Accounts for 20% of the enhanced greenhouse effect.
- Lower concentrations than carbon dioxide, it produces 21 times as much warming as CO_2.
- Two thirds of global methane comes from man-made sources, such as the burning of fossil fuel, the accidental release during drilling for natural gas or from cattle ranching.

Hydrocarbons

- An organic compound consisting of hydrogen and carbon
- Mineral resources from plants and marine animals
- Primary energy source for current civilizations
- Methane, coal, crude oil, natural gas
- Extracted from sedimentary basins, tar sands and oil shale
- Energy is produced when burnt

What is Global Warming?

Lesson Objectives:

- To understand what is meant by ‘global warming’
- To know what we think causes global warming.
- To begin to understand how our activities can cause climate change.

http://science.howstuffworks.com/environmental/29272-100-greatest-discoveries-global-warming-and-co2-video.htm

The consequences of a global temperature rise on arctic ecosystems.

- Global warming seems to have the largest and most obvious effects right now on the arctic ecosystems.
- The Arctic includes the areas of North America, Greenland, Iceland, Norway and Russia which are north of the Arctic Circle.
- It also includes Arctic Ocean which is covered by a huge mass of ice surrounding the North Pole.

The consequences of a global temperature rise on arctic ecosystems.

Over the century there have been many changes in the ecosystems in this area noted by scientists and the people who live there. These changes include the following:

- Increased amounts of ice melting each year.
- Winter snowfall has decreased and frozen rain increased.
- Mosquitoes are found in regions where they have never been.
- Soils that once only supported lichens and mosses are now warmer and supporting woody shrubs.
- Some species of birds (robins) are now living in areas where they have never been seen before and a name does not exist in their language for these birds.

Predicting the impact on arctic ecosystems.

- Scientists predict that what we have seen is only the beginning and the effects will be more extreme during this century.
- All habitats around the world will be affected but it is expected that the most catastrophic effects will be seen in the Arctic.
- The following lists some predictions for the Arctic as a result of global warming:

- The melting of glaciers and breaking of polar ice sheets into icebergs that will eventually melt. The Arctic ice cap may disappear altogether.
- The permafrost will begin melting during the summer which means the rate of decomposition will increase resulting in the release of more carbon dioxide.
- Species will have to move north which will alter food chains and disrupt animals in the higher trophic levels.

- Many marine species could face extinction due to their sensitivity to temperature changes in the ocean.
- Polar bears and other ice dwelling organisms will lose their habitat where they feed and breed.
- Warmer temperatures will increase the threat of pests and disease.
- The rise in sea levels will flood low-lying areas.
- Extreme weather events (storms) will become more frequent.

DEFINITION for Air Pollution

It is defined as any atmospheric condition in which certain substances are present in such concentrations that they produce undesirable effects on humans and environment.

Common Air Pollutants

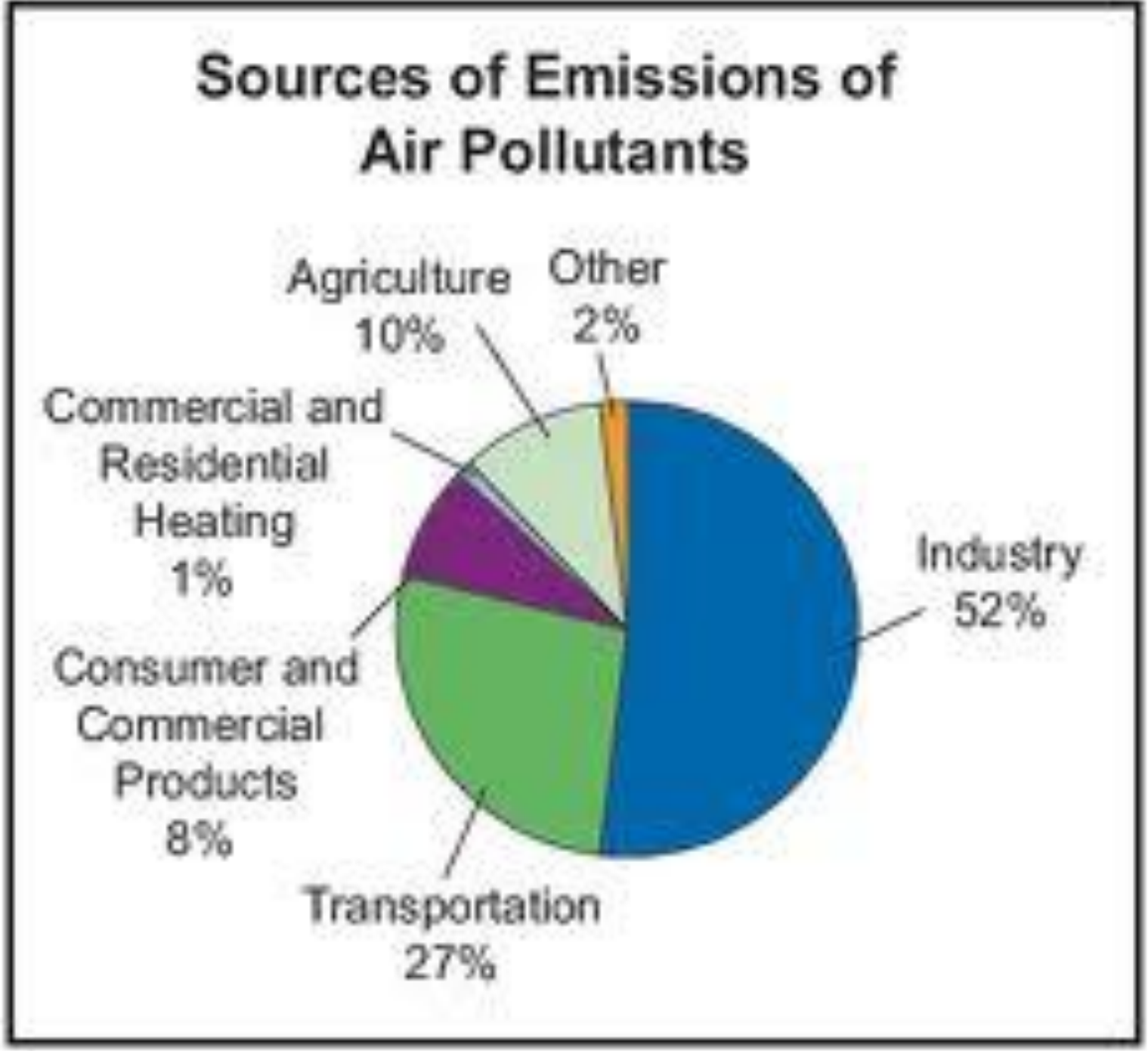
Six major types of pollutants

1. **Carbon monoxide**
2. **Hydrocarbons**
3. **Nitrogen oxides**
4. **Particulates**
5. **Sulfur dioxide**
6. **Photochemical oxidants.**

Sources of Air Pollution

Four major human sources

1. **Power and heat generation**
2. **Burning of solid wastes**
3. **Industrial processes**
4. **Transportation**


Sources of Emissions of Air Pollutants
Agriculture 10%
Other 2%
Commercial and Residential Heating 1%
Industry 52%
Consumer and Commercial Products 8%
Transportation 27%

Sources of Pollution

Four major natural sources

- **Volcanic eruptions(ash and dust)**
- **Dust from loose and dry soils**
- **Pollen**
- **Spores**

Categories of Pollutants

Secondary

- Form when a primary pollutant comes in contact with other primary pollutants or naturally occurring substances like water vapor and a chemical reaction occurs.

Example

- Ozone – Forms when oxygen in the air reacts with volatile organic compounds (VOCs) and other air pollution from trucks, cars, and natural sources in the presence of the sun's ultraviolet rays.

Carbon Monoxide (CO)

- Odorless, poisonous gas

Effects

- Interferes with the blood's ability to carry oxygen, slowing reflexes and causing drowsiness

Sulfur Dioxide (SO_2)

Description

- Produced cy chemical reactions between sulfur and oxygen

Primary Sources

- Comes largely from burning fossil fuels. Released from petroleum refineries, smelters, paper mills, chemical plants, and coal-burning power plants

Effects

- Contributes to acid rain, which damages lakes, forests, metals, and stone.

Nitrogen Oxides (NO_x)

Primary Sources

- Comes from burning fuels in vehicles, power plants and industrial boilers.

Effects

- Can make the body vulnerable to respiratory infections, lung disease, and possibly cancer.
- Contributes to the brown haze often seen over congested areas
- Contributes to acid rain
- Causes metal corrosion and the fading and deterioration of fabrics

Volatile Organic Compounds (VOCs)

Description

- Organic compounds that vaporize readily, producing toxic fumes.

Primary Sources

- Come from the burning of fossil fuels and from solvents, paints, and glues.

Effects

- Contribute to smog formation and can cause serious health problems, such as cancer.

Causes of Air Pollution

- One of the main causes of air pollution is the release of carbon dioxide into the atmosphere, this happens because of deforestation and fossil fuel burning
- Sulfur dioxide is another air polluter and is released into the atmosphere by the burning of sulfur containing compounds of fossil fuels. Sulfur oxides are very dangerous to humans at a high concentration. Sulfur in the atmosphere is responsible for acid rain

Focus Question

How do humans affect air quality?

- Pollutants from human activities can easy combine with the atmosphere gasses.
- Pollutants become mobile and can negatively impact areas other than where they originate.
- Areas exposed to even low concentrations of pollutants can be impacted.

Air Pollution on the Biosphere

- Acid Shock - pH change of the environment
- Cause aluminum to leech out of the soil surrounding a lake. Aluminum accumulates in the gills of fish, stimulating the mucus production. Fish slowly suffocate from the build of this mucus on their gills
- Cause fish and amphibians to produce few eggs that usually do not hatch
- Weakens the hardness of bird egg shells causing a loss of production regeneration
- Trees foliage is burned, and increases in soil ph cause trees to die

Consequences of Air Pollution

- CO_2 is a good transmitter of sunlight, but it also partially restricts infrared radiation going back from the earth into space, which produces the so-called greenhouse effect that prevents a drastic cooling of the Earth during the night
- Increasing the amount of CO_2 in the atmosphere reinforces this effect and is expected to result in a warming of the Earth's surface
- CO_2 in atmosphere → **GLOBAL WARMING**

Acid Rain

- When emissions of sulfur dioxide and nitric oxide from stationary sources are transported long distances by winds, they form secondary pollutants such as nitrogen dioxide, nitric acid vapor, and droplets containing solutions of sulfuric acid, sulfate, and nitrate salts
- These chemicals descend to the earth's surface in wet form as rain or snow and in dry form as a gases fog, dew, or solid particles, it is known as acid rain or acid deposition

Smog

- With the introduction of petroleum to replace coal economies in countries, photochemical smog has become predominant in many cities, which are located in sunny, warm, and dry climates with many motor vehicles
- Worst episodes of photochemical smog tends to occur in summer

Consequences continued

- Sulfur dioxide, nitrogen oxides, ozone and, cause direct damage to leaves of crop plants and trees when they enter leaf pores .

- Chronic exposure of leaves and needles to air pollutants can also break down the waxy coating that helps prevent excessive water loss and damage from diseases, pests, drought and frost

Consequences continued

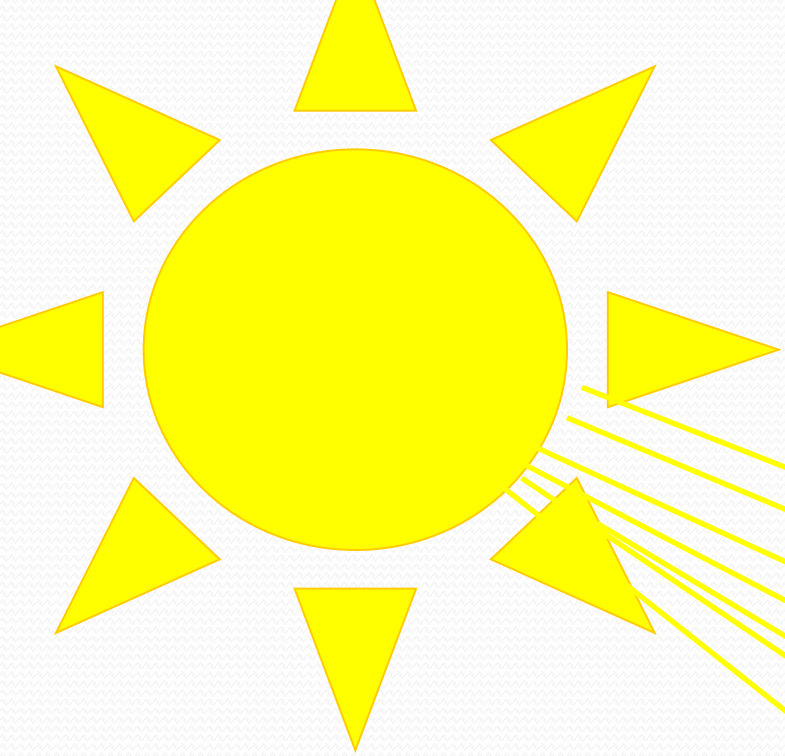
"In the midwestern United States crop losses of wheat, corn, soy beans, and peanuts from damage by ozone and acid deposition amount to about $5 billion a year".

Changes in Society and the Economy

- Population growth
- Industrialization
- Growth and distribution of wealth
- Changing social attitudes
- Environmental activism

Reduction of Air Pollution

- Pollutant levels are monitored. If levels are found to be greater than permissible, local authorities are contacted and a plan to bring levels down is implemented.
- Power plants and motor vehicle use pollution control devices to reduce or eliminate by products of fossil fuel burning.
- Increase use of clean alternate energy sources, such as solar, wind and hydroelectric power
- Design of electric and hybrid cars
- Energy efficiency improvements
- Cleaner fuels



The sun sends out energy as heat and light. This energy comes to our earth during the day time.

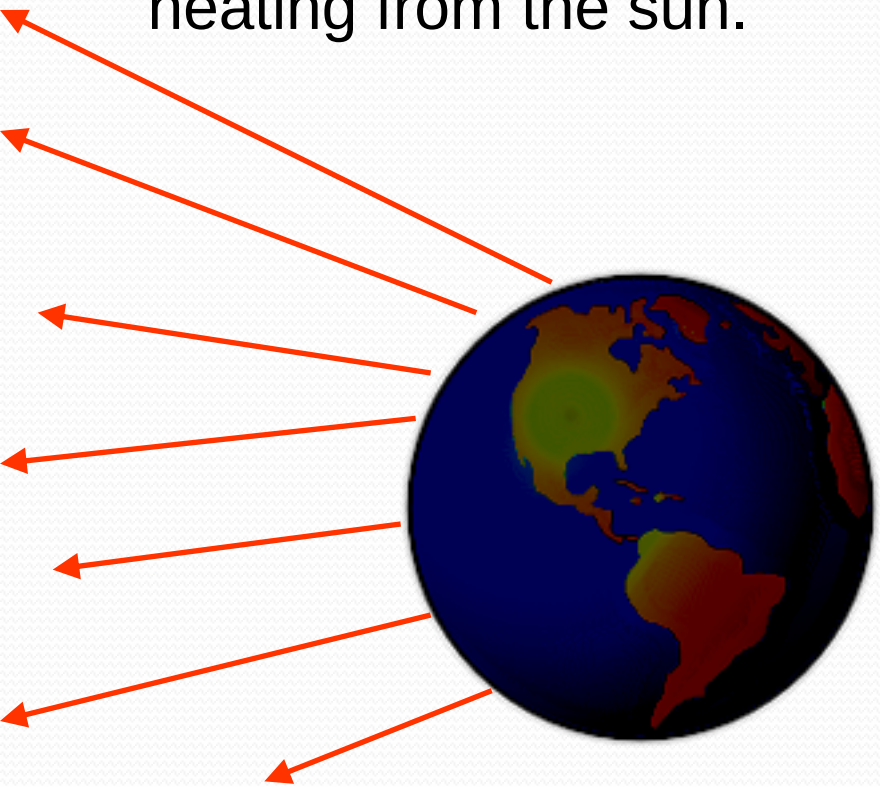
Some of the sun's rays get 'trapped' in the atmosphere.

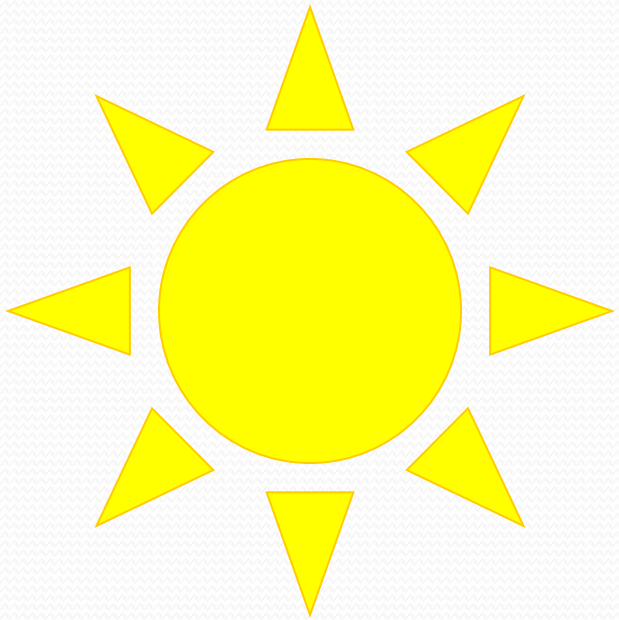
Some of them get reflected back into space.

The ones which get through the atmosphere warm the earth up.

Copy these pictures to your notes

All the time, the earth radiates heat into space, which cools it down. We only really notice this at night, when there is no heating from the sun.





Some of the heat going out is trapped by the atmosphere. This is what makes our planet warm enough to live on.

But if too much heat is trapped, our planet will warm up and the climate will change.

Copy these pictures to your notes

What is the atmosphere and why does it trap heat?

The atmosphere is the air around the surface of the earth. It is made from a mixture of gases. We need it for animals and plants to survive.

Some of the gases act like a blanket, trapping heat. These gases are called **'greenhouse gases'**.

This is known as the '**Natural Greenhouse Effect'.** Without it, the earth would be much colder.

(the atmosphere is really much thinner than it looks above)

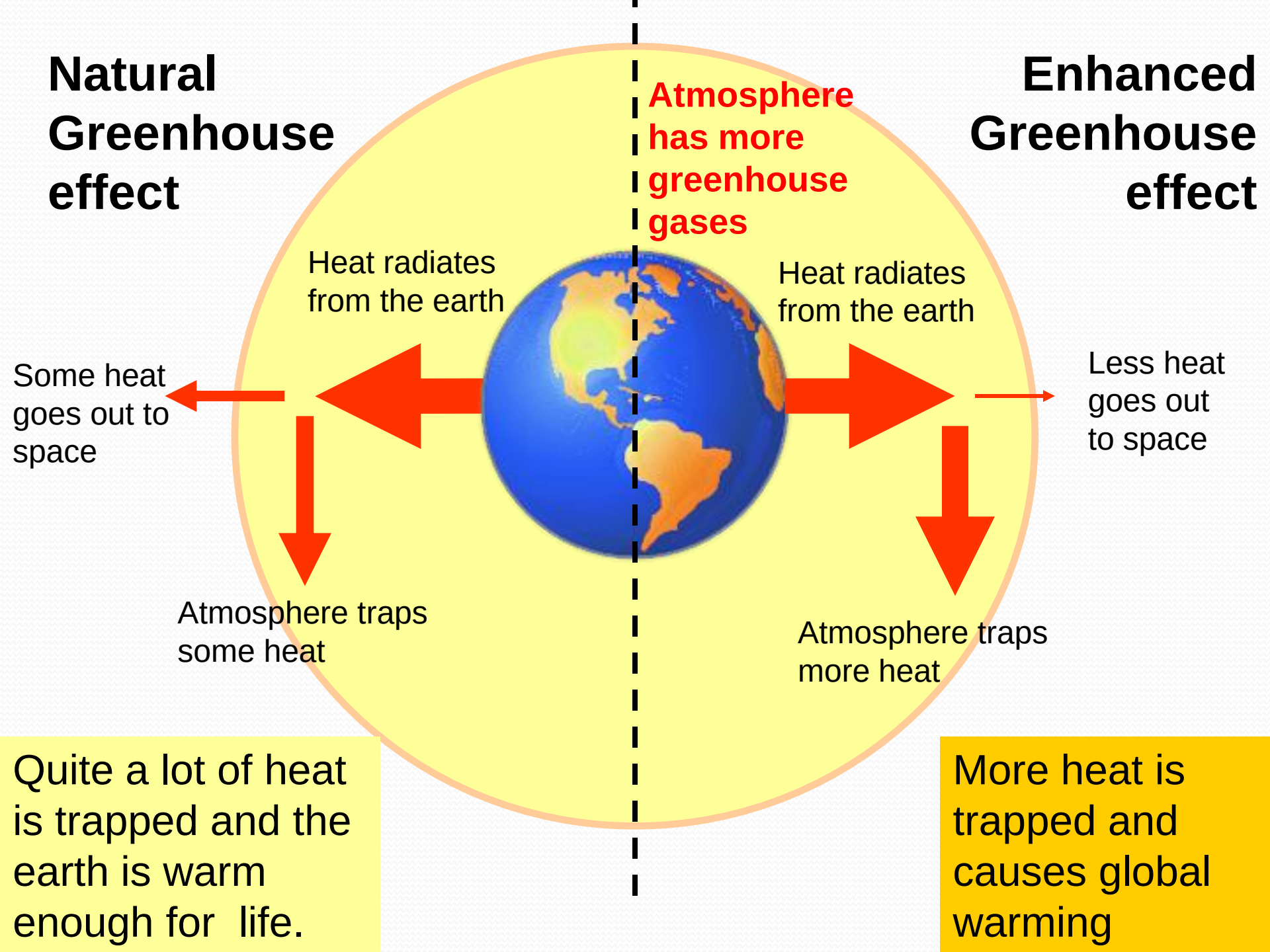
So why is global warming happening?

Some things that people do are increasing the amounts of the greenhouse gases in the atmosphere, so more heat is trapped.

The heating of the earth through human activities is called the **'Enhanced Greenhouse Effect'** and this is causing the earth to heat up, or **global warming.**

Global warming doesn't just mean that the earth gets hotter, it means that the whole **climate is changing.**

(the atmosphere is really much thinner than it looks above)


Natural Greenhouse effect
Enhanced Greenhouse effect
Atmosphere has more greenhouse gases
Heat radiates from the earth
Heat radiates from the earth
Some heat goes out to space
Less heat goes out to space
Atmosphere traps some heat
Atmosphere traps more heat
Quite a lot of heat is trapped and the earth is warm enough for life.
More heat is trapped and causes global warming

Which gases in the atmosphere trap heat?

The atmosphere is made of 78% Nitrogen and 21% Oxygen.
But these gases **don't** trap heat and cause global warming or climate change.
What % of the atmosphere is left?

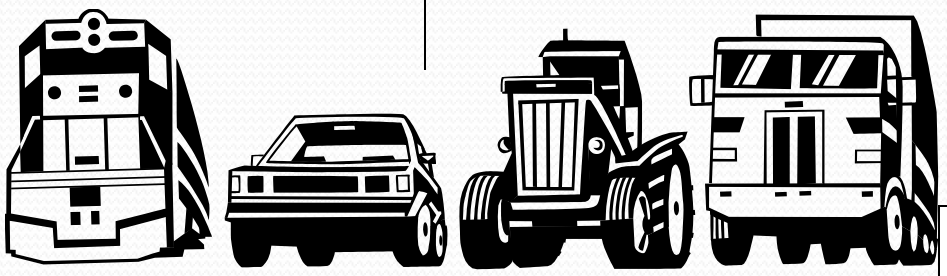
The gases which trap heat make up less than 1% of the atmosphere! They are called the 'greenhouse gases'.

The main greenhouse gases are:
Carbon dioxide
Methane
Nitrous oxide
Ozone
Water vapour
Halocarbons

Human activity increases the amount of these gases in the atmosphere

How do humans increase carbon dioxide levels in the atmosphere?

Burning **fossil fuels** releases the carbon dioxide stored millions of years ago. Most of the increased carbon dioxide comes from fossil fuels

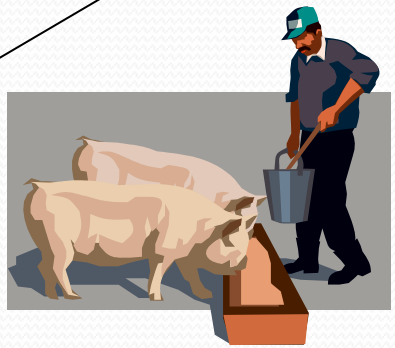


Deforestation releases the carbon stored in trees. Less trees also means less **carbon dioxide** can be removed from the atmosphere.

How do humans increase methane levels in the atmosphere?

Methane is produced when bacteria rot **organic matter**

Increased rice growing



Increased livestock farming

Increased rubbish in landfill

Methane is also released when **fossil fuels are extracted**

The amount of **methane** in the atmosphere has increased by two and a half times since the Industrial Revolution.

Imagine that…

You are an intern working with a U.S. Senator who is required to make important decisions about legislation designed to limit the impacts of global climate change.

Your job is to help the Senator…

- ✓ Understand the science behind climate change.
- ✓ Appreciate the impact of global climate change.
- ✓ Assess the effects of human activities on global climate change.