Man Made Global Climate Change

Essential Standard 2.6

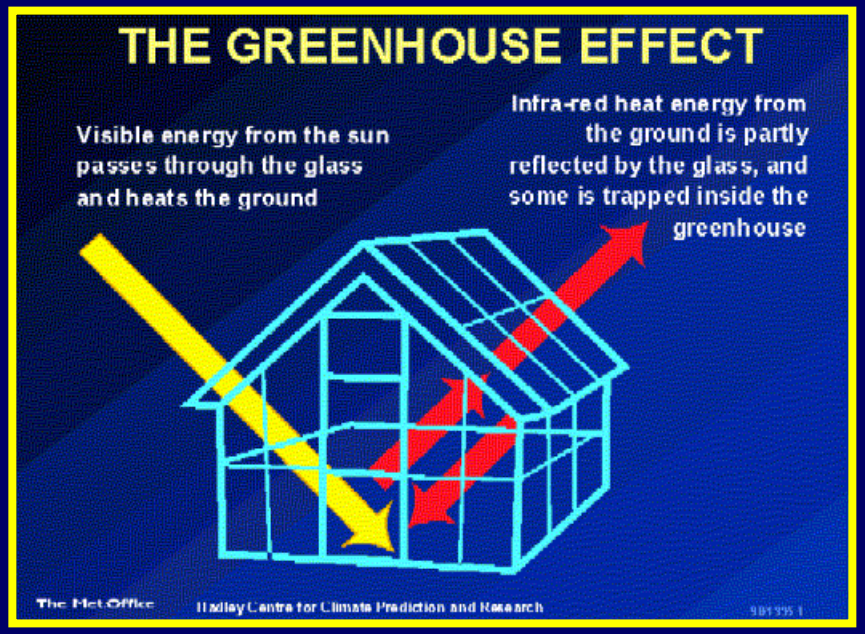
Analyze patterns of global climate change over time.

Learning Objective 2.6.3

Analyze the impacts that human activities have on global climate change such as the burning of hydrocarbons, greenhouse effect, and deforestation.

Greenhouse Effect

Overall, the Earth's global temperature is also due to what is called the Greenhouse Effect.



A Greenhouse, made of glass, allows light waves through that then heat objects inside the greenhouse.

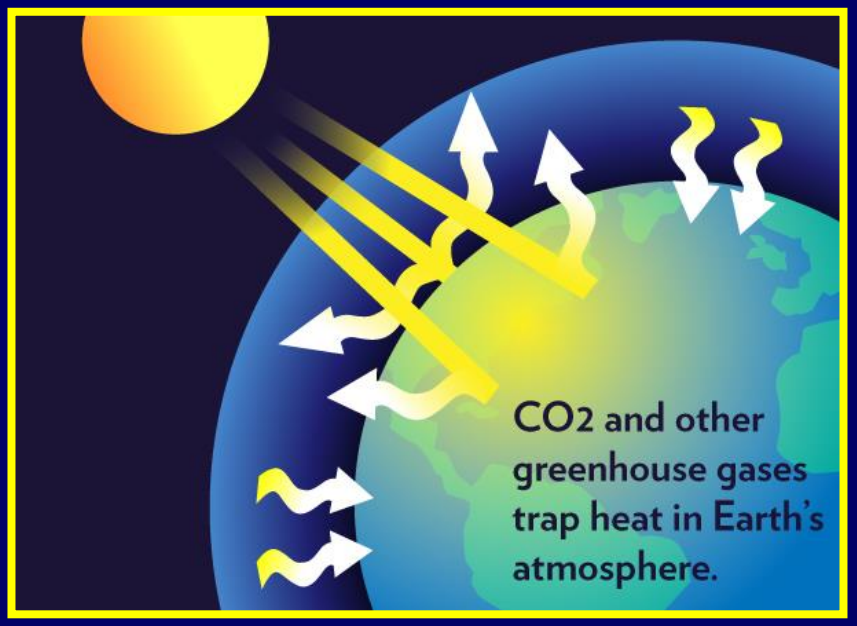
Heated objects emit infrared or heat waves, that cannot pass through glass are trapped, thus warming the greenhouse.

Greenhouse Effect

The same effect takes place inside cars that sit in the Sun during the summer.

Greenhouse Effect

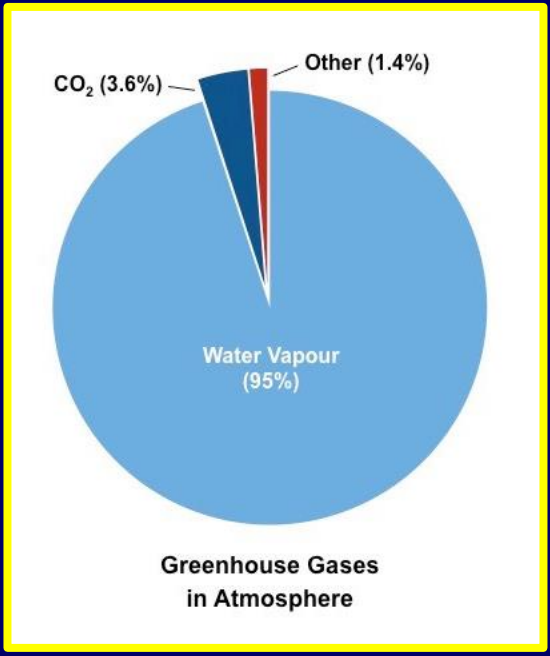
When sunlight enters Earth's atmosphere, some light waves are reflected into space.

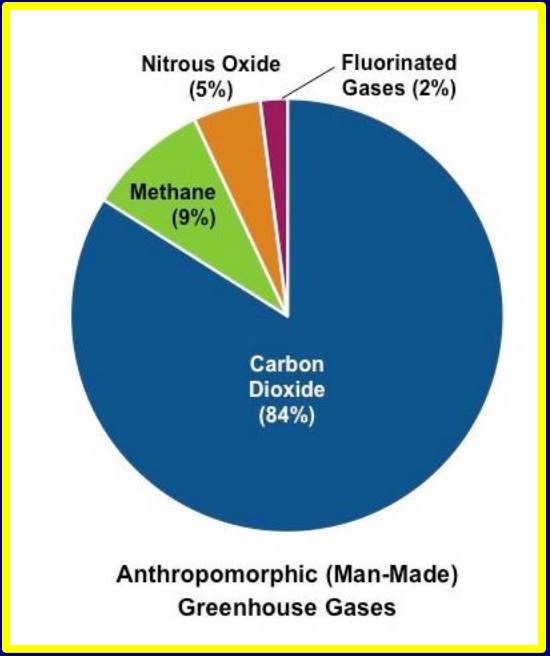


The rest becomes infrared radiation and are trapped by the greenhouse gases in the atmosphere, resulting in a warming of Earth.

Greenhouse Effect

The two most important greenhouse gases are water vapor and carbon dioxide.

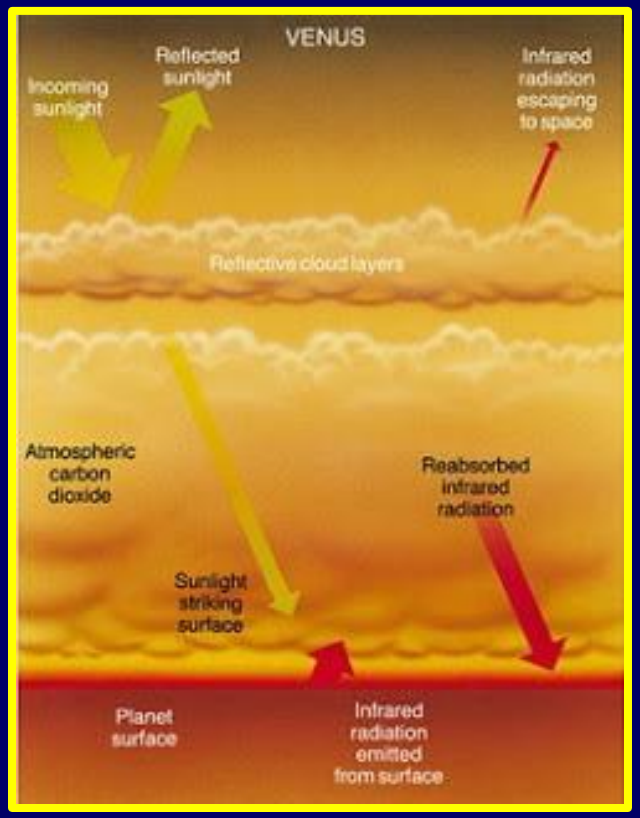




Other greenhouse gases include methane, nitrous oxides, and chlorofluorocarbons.

Runaway Greenhouse Effect

Too much carbon dioxide can result in a runaway greenhouse effect.

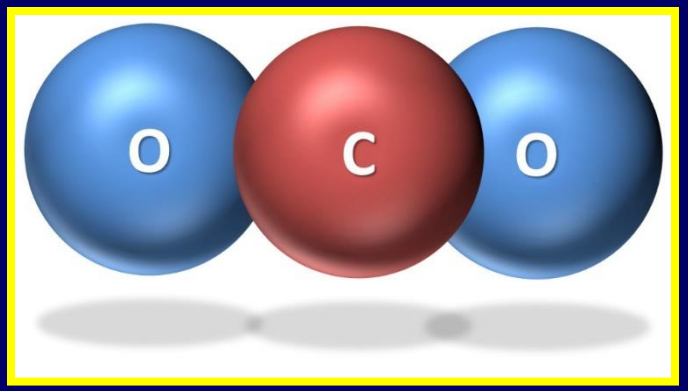


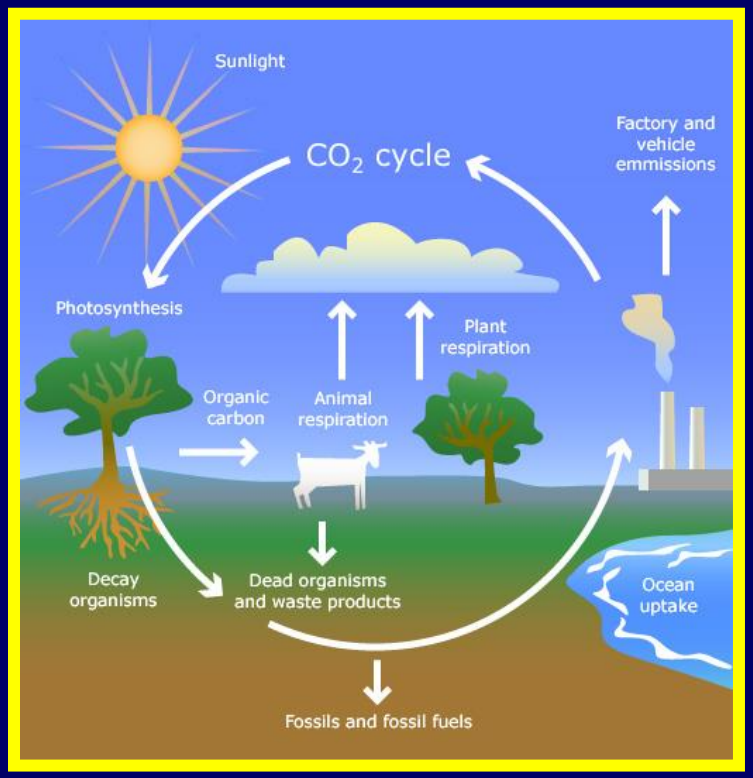
96% of the atmosphere on Venus is made up of carbon dioxide.

The temperature on Venus can reach as high as 972 ^{o}F, hot enough to melt lead.

Carbon Cycle

Carbon dioxide, CO_2, molecules consist of one carbon atom bonded to the two oxygen atoms.

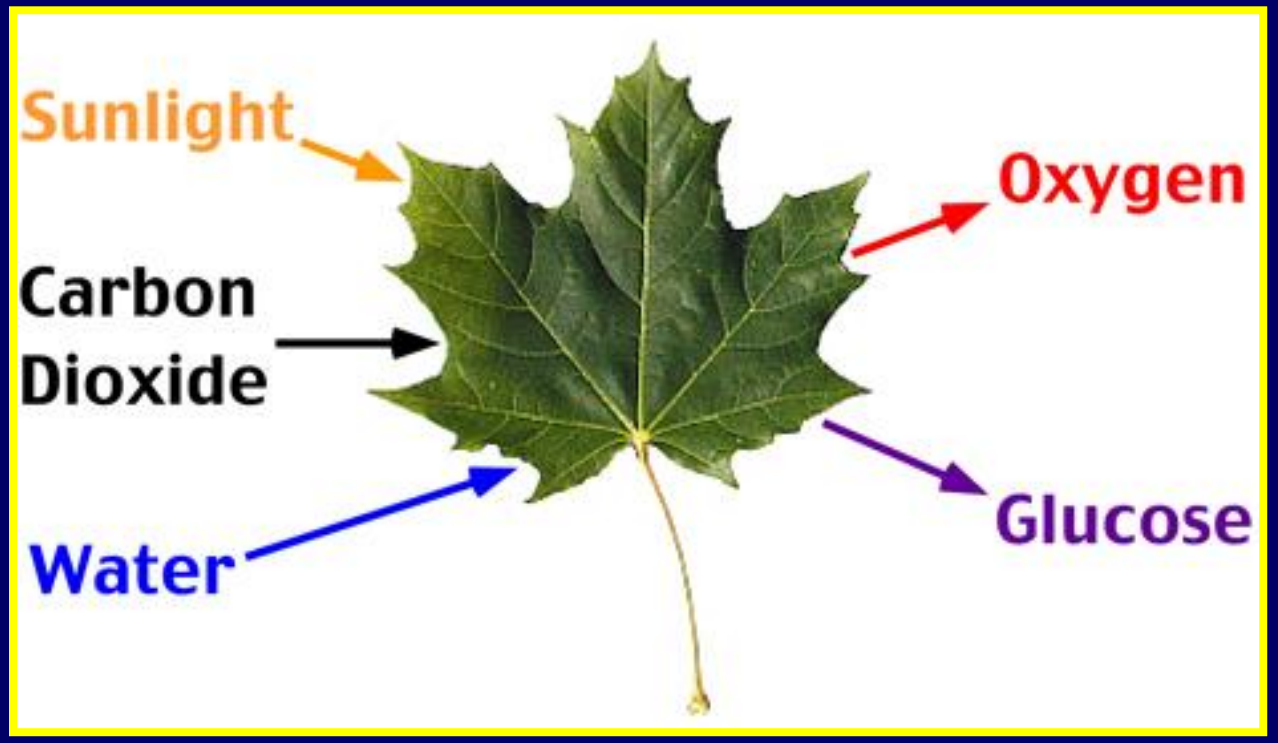




Carbon dioxide, CO_2, is cycled through the atmosphere, hydrosphere, lithosphere, and biosphere through processes that make up the carbon cycle.

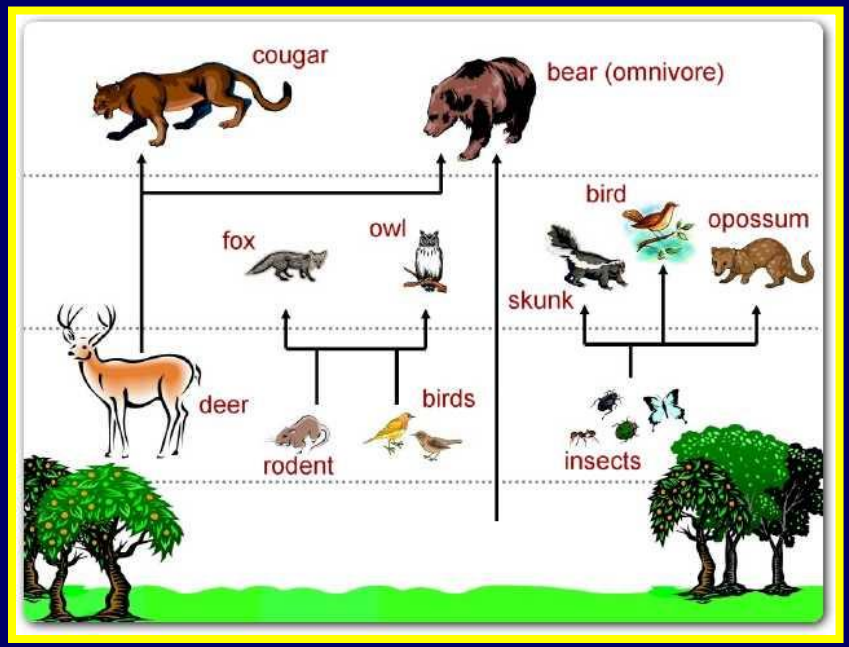
Photosynthesis

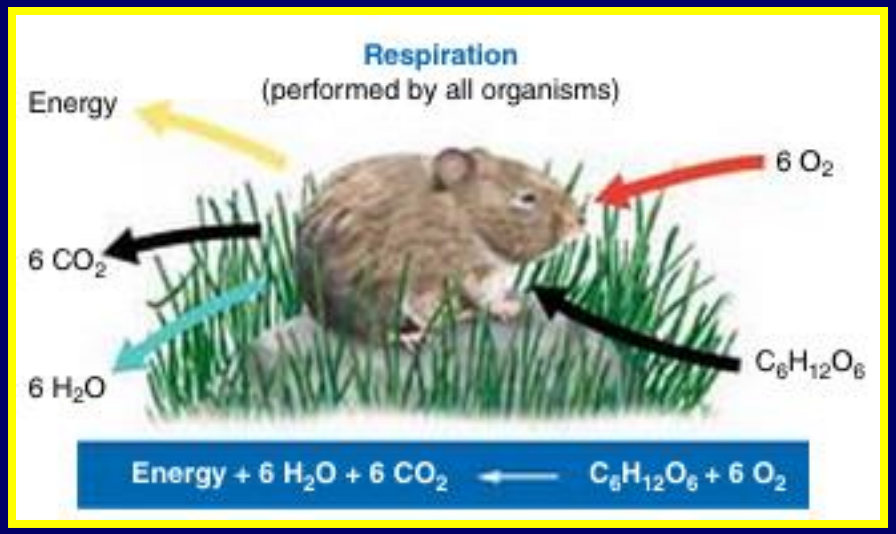
During photosynthesis, plants, plankton, other algae, and cyanobacteria remove carbon dioxide, CO_2, from the atmosphere and use light energy to convert the carbon into glucose, $C_6H_{12}O_6$.



Respiration

Carbon, in the form of glucose, $C_6H_{12}O_6$, is then passed through the food chain.





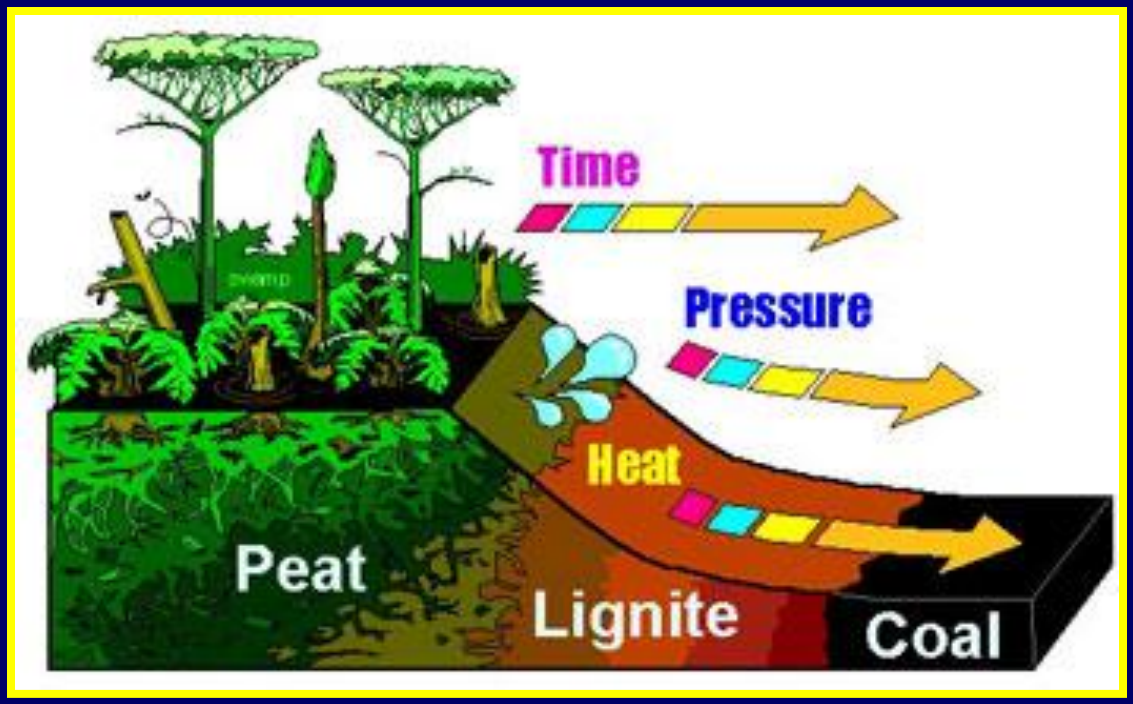
As food is broken down, carbon dioxide, CO_2, is released back into the atmosphere through the process of respiration.

Decomposition

Decomposition also releases carbon dioxide, CO_2, into the atmosphere, as plant and animal wastes are broken down by decomposers.

Fossil Fuels

Organic matter, rich in carbon, that is not decomposed ends up being buried and, overtime, due to heat and pressure, turns into carbon-rich fossil fuels such as coal, oil, and natural gas.



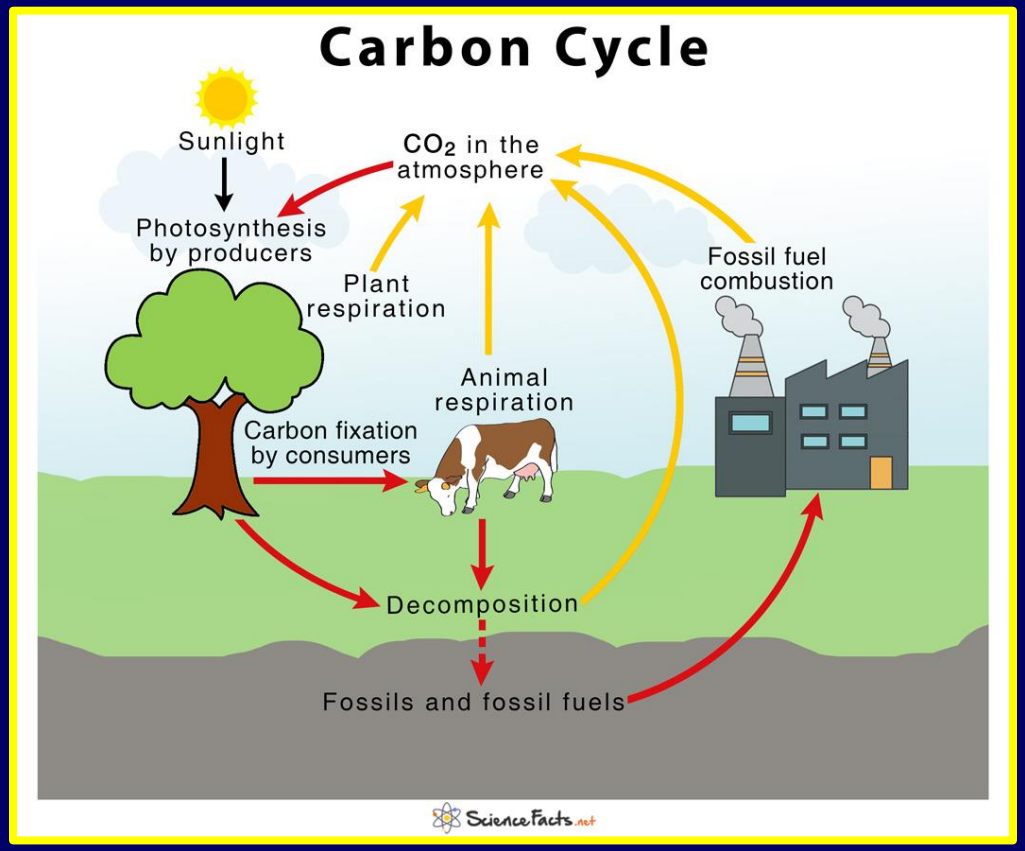
Combustion

When fossil fuels are burned, during a process called combustion, large amounts of carbon dioxide, CO_2, are released into the atmosphere.

Combustion also occurs when wood is burned and carbon dioxide, CO_2, is released.

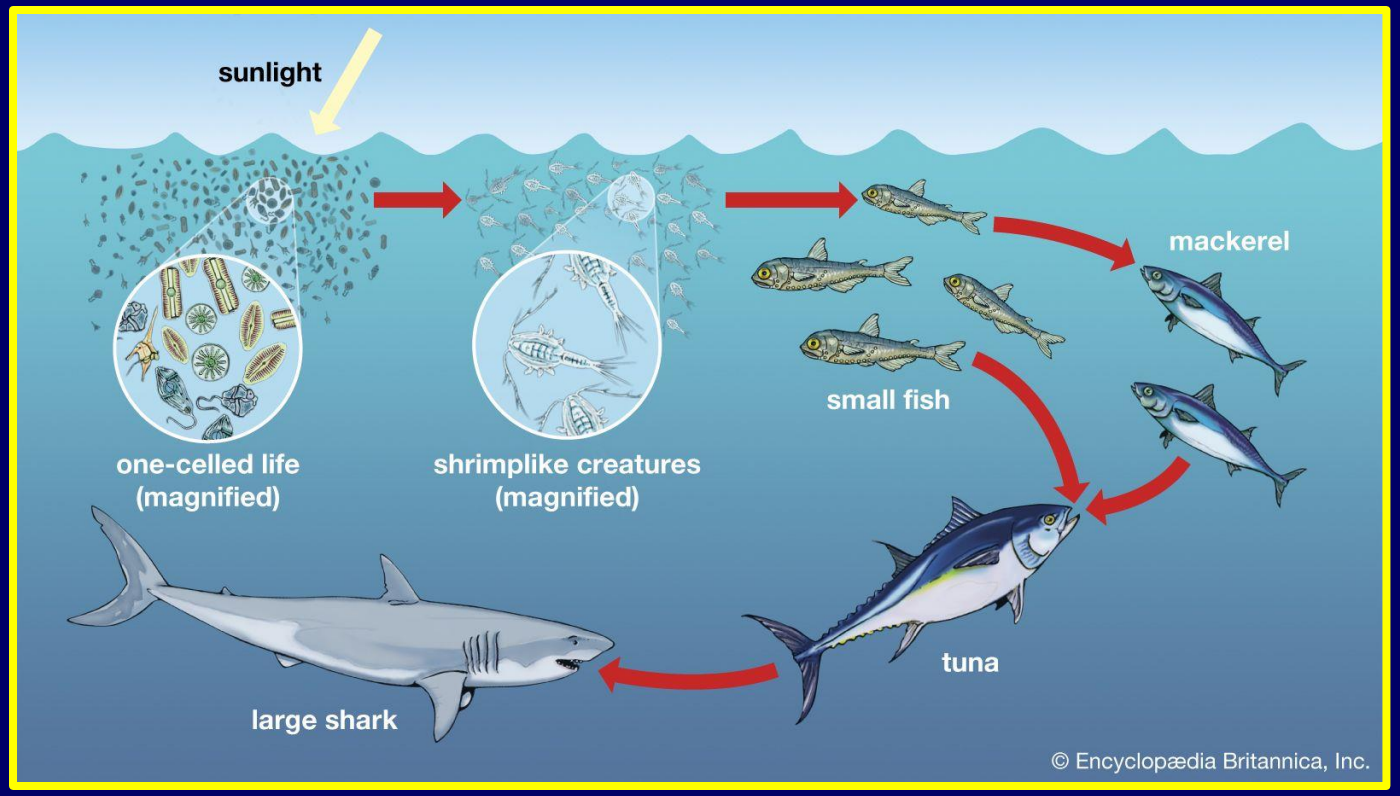
Carbon Cycle

The cycling of carbon dioxide, CO_2, through the atmosphere, biosphere, lithosphere, and hydrosphere is called the Carbon Cycle.



Aquatic Carbon Cycle

The cycling of carbon dioxide, CO_2, also occurs in aquatic ecosystems with phytoplankton removing CO_2, from the atmosphere or water to produce glucose, $C_6H_{12}O_6$, that is passed up the food chain.

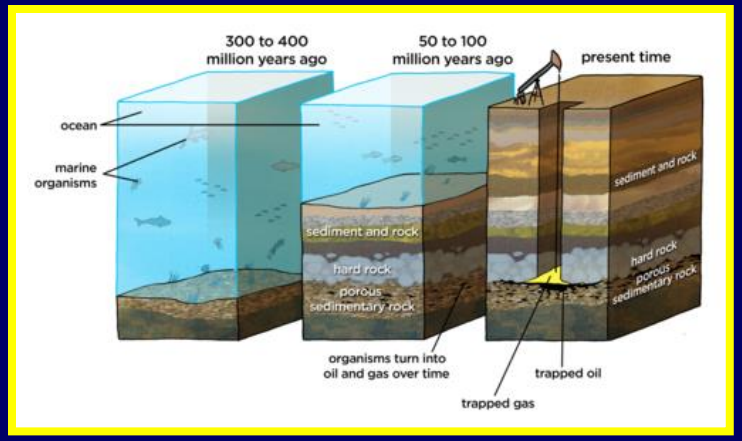


Carbon Sinks

Carbon sinks are places where carbon is stored for long periods of time, thus removing it from the carbon cycle so it doesn't enter the atmosphere.

The ocean is the largest carbon sink, as it can hold enormous amounts of dissolved carbon dioxide.

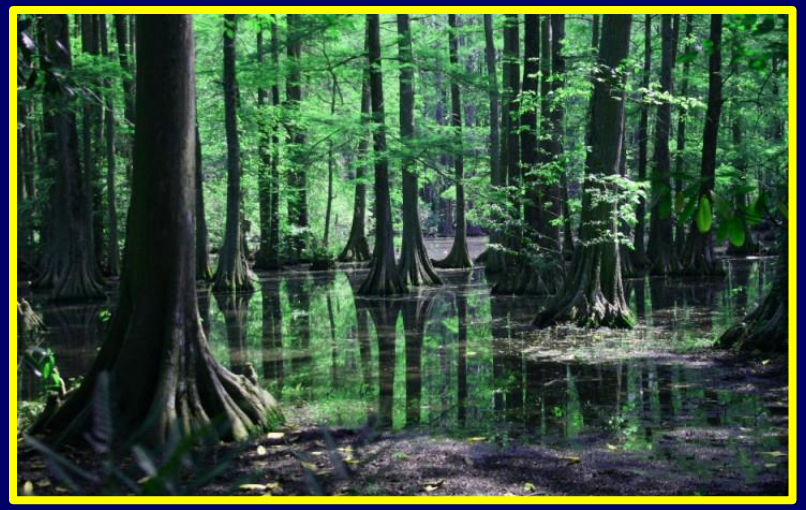
Organic wastes of marine organisms also become buried and over time and are turned oil and natural gas.



Carbon Sinks

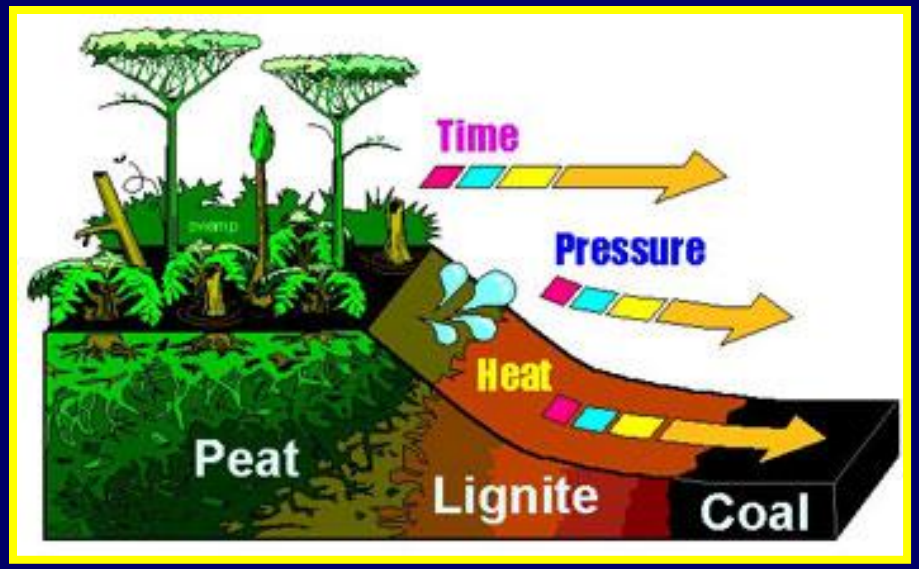
Trees and forests are also large carbon sinks, as the plants use and store the carbon as they make their bark, branches, and leaves.

Carbon Sinks



Trees that died in swamps millions of years ago were unable to decompose due to the lack of oxygen in the water and soil.

The dead trees were eventually buried and over time, heat and pressure turned the carbon rich material into coal.

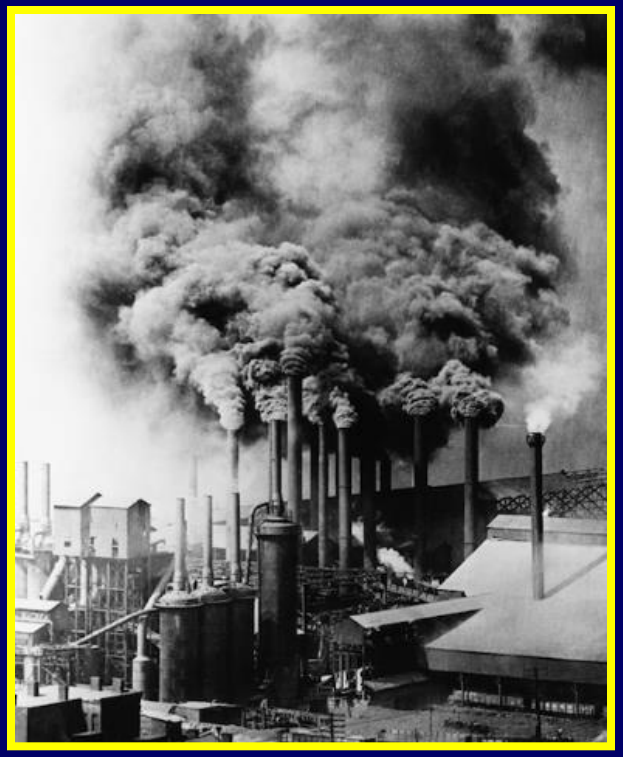


Carbon Sinks

Coal is a carbon sink, as it takes millions of years to form and remains underground until removed.

Industrial Revolution

When the industrial revolution began in the mid-1800's, coal was mined and used as the main energy source, releasing large amounts of carbon dioxide into the atmosphere.



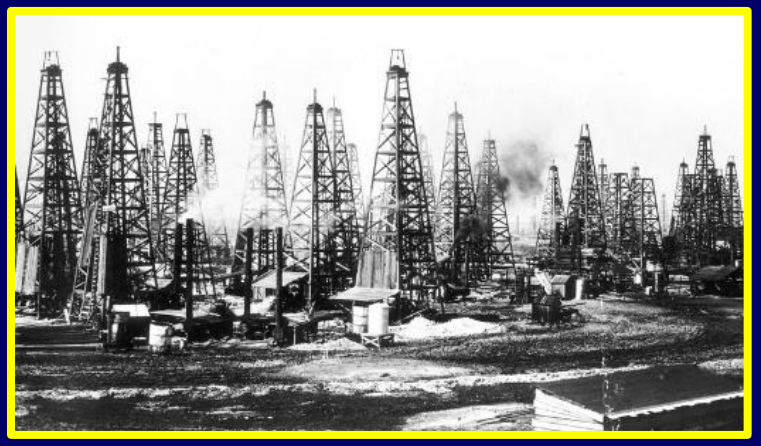
Industrial Revolution

With better machinery and trains for transport, much of the forests were logged and used for timber.

In some places, forests were cleared through the slash and burn method to make room for agriculture.

Industrial Revolution

In the early 1900's, better techniques were used to drill for oil creating a large oil boom.

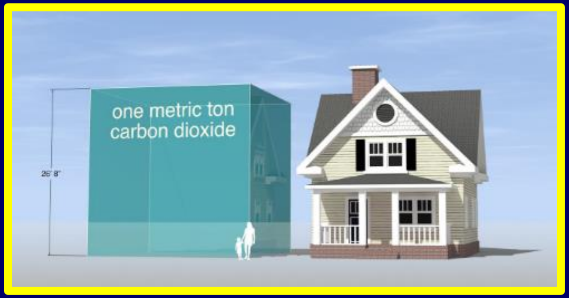


While coal was still the main source for electrical power, homes and businesses began switching over to oil and natural gas for heat.

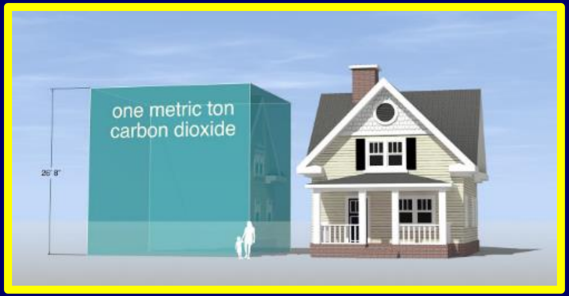
Ships, trains, and automobiles further increased the demand for oil.

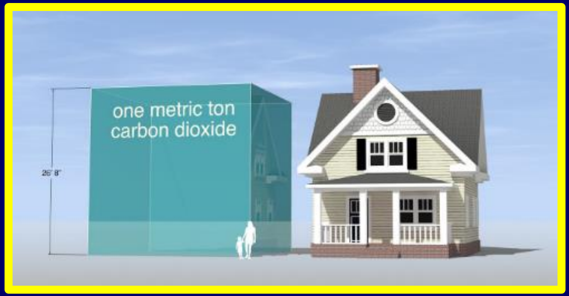
7.5 tons of CO_2

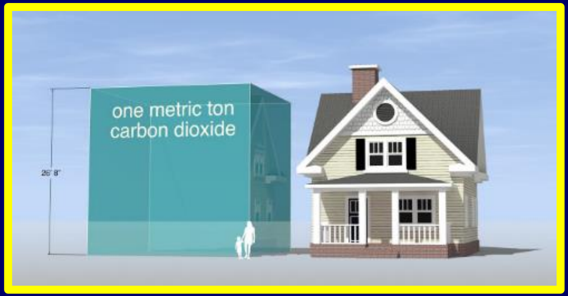
The average car that gets 20 miles to the gallon releases 7.5 tons of carbon dioxide gas into the atmosphere each year.

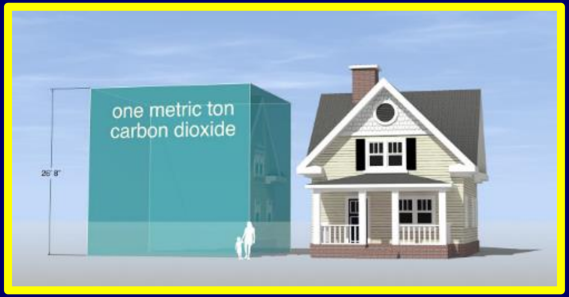


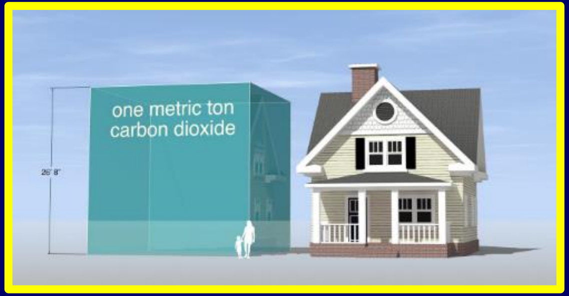
After 100 years, 3.75 tons of that is still left in the atmosphere.

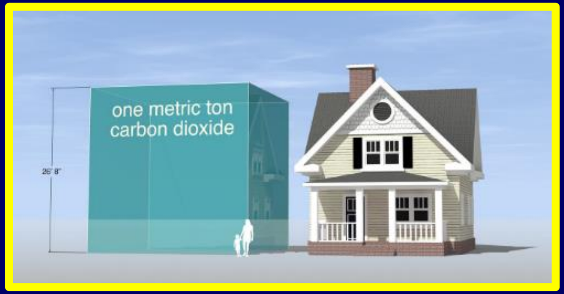






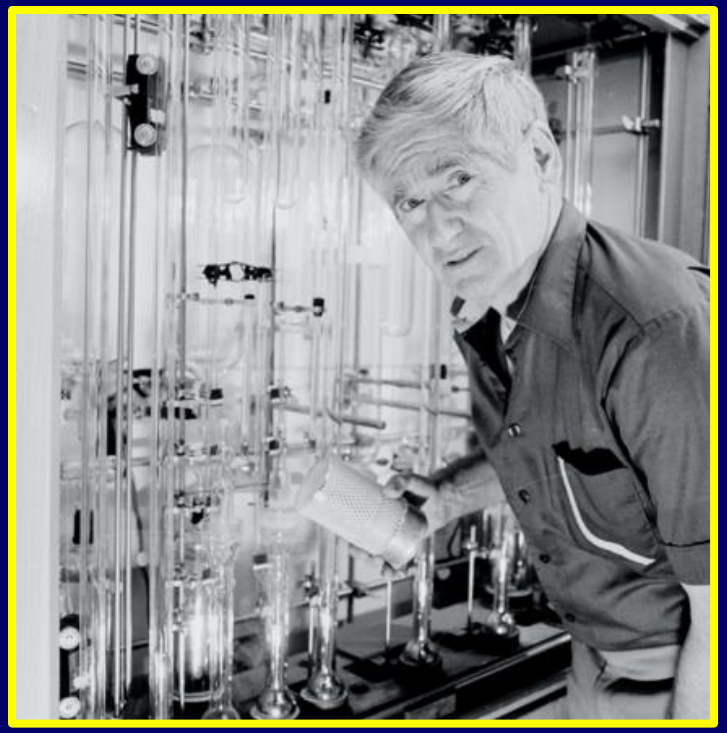






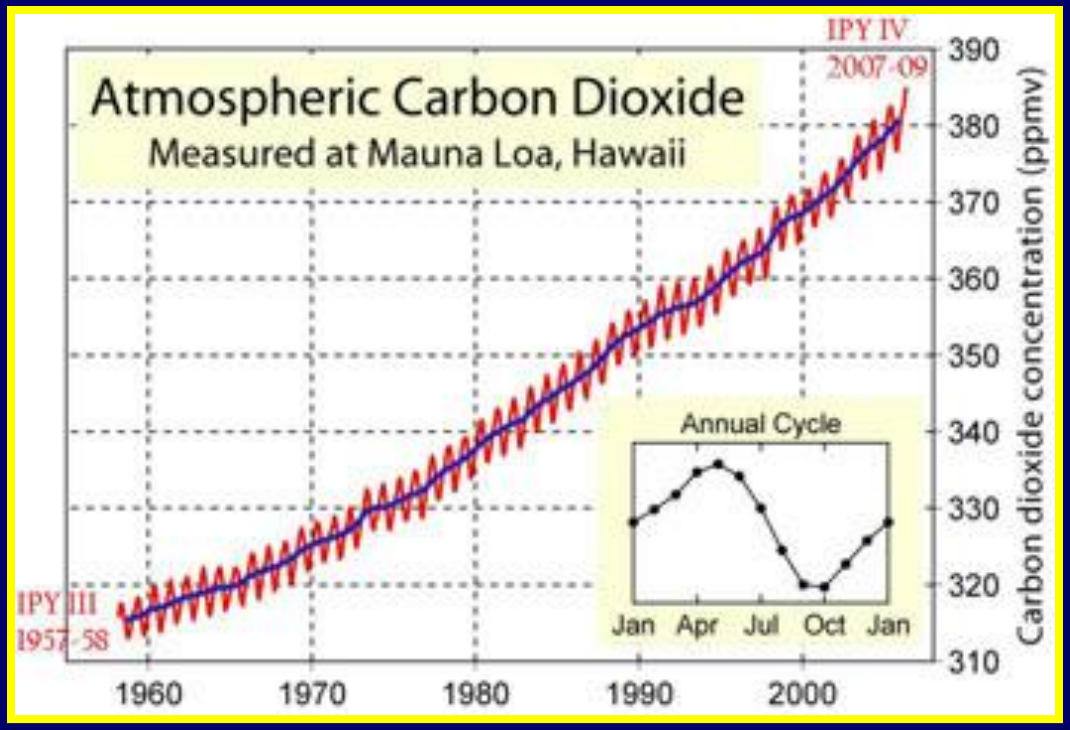
Measuring Atmospheric CO_2

In the mid-1950's, a geophysics professor, named Charles David Keeling, began recording atmospheric carbon dioxide levels in the atmosphere from on top of an Hawaiian volcanic island called Mauna Loa.



The Keeling Curve

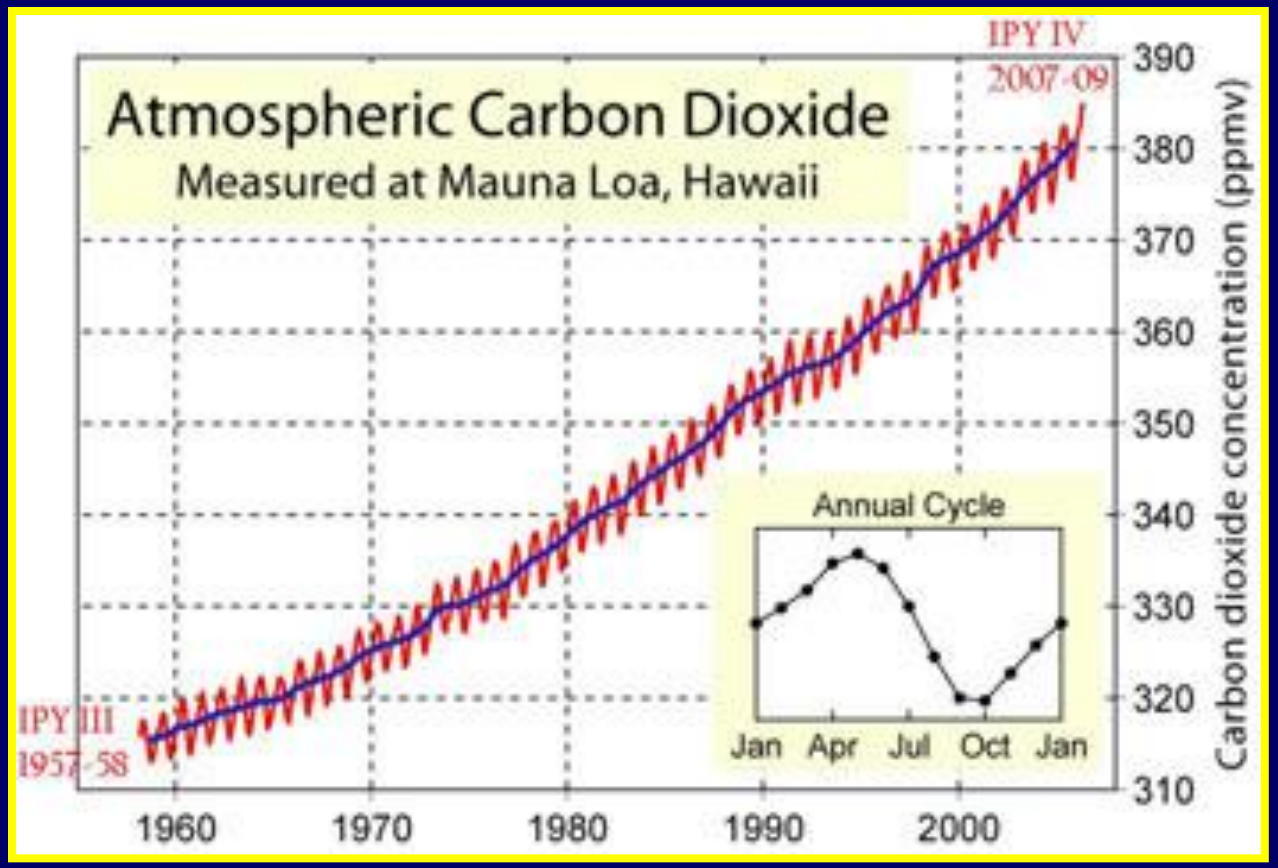
The first recorded measurements of atmospheric carbon dioxide, back in 1955, was 315 parts per million, ppm.

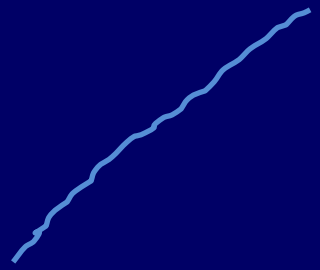


PPM = $\frac{\text{1 carbon dioxide molecule}}{\text{1,000,000 air molecules}}$

Overall Increase

Regardless of the up and down seasonal change, Keeling measured and recorded an overall increase in the levels of atmospheric carbon dioxide.

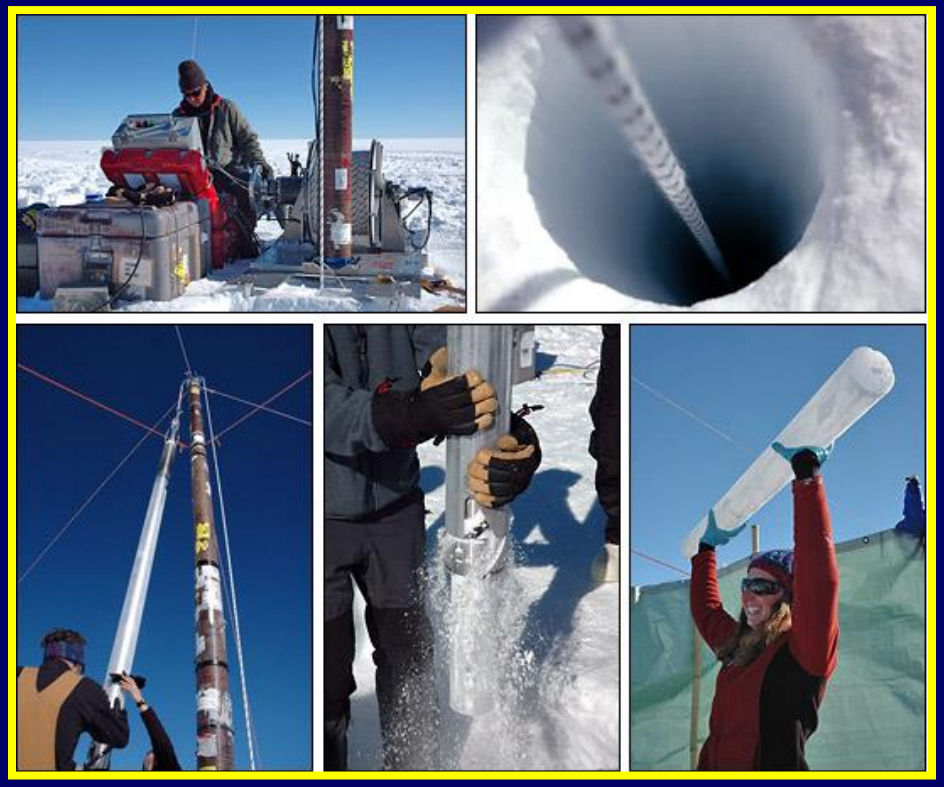




Overall trend

Ice Core Data

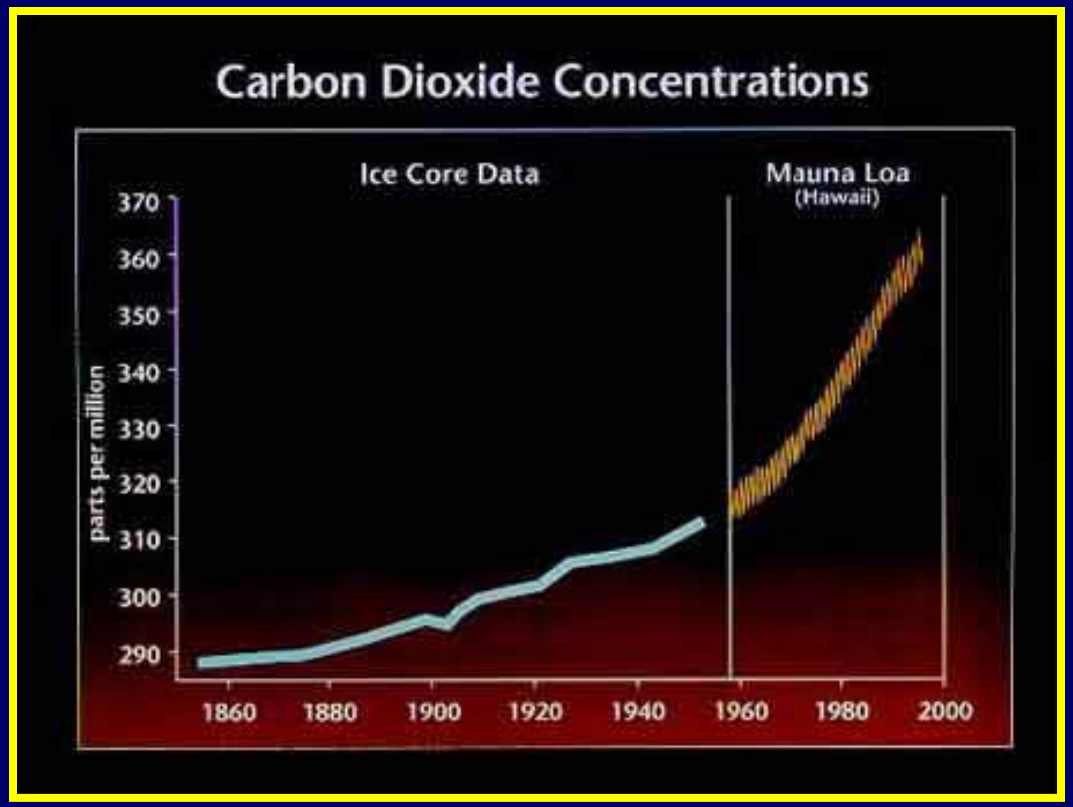
Ignited by Keeling's measurements, other scientists began finding ways to measure historic levels of atmospheric carbon dioxide.



One source of information about ancient climates was found in ice cores, where bubbles containing ancient air were trapped and frozen in time.

Industrial Revolution

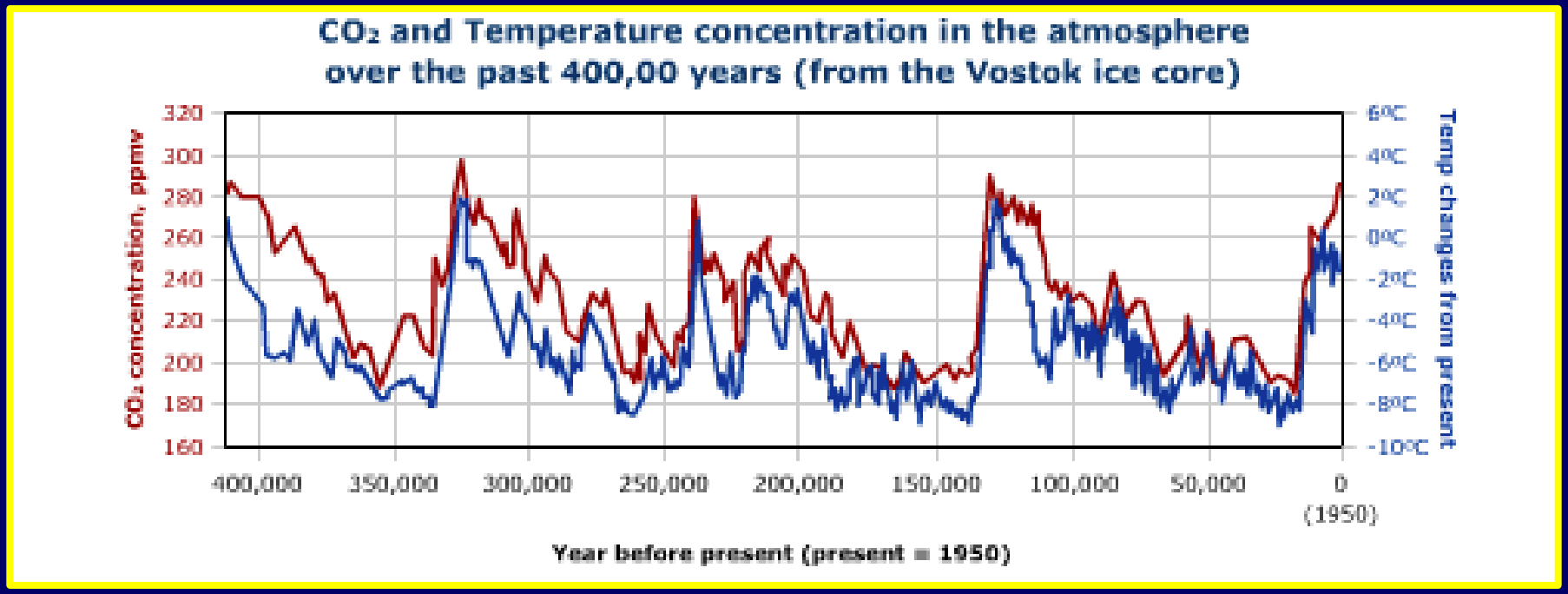
Ice core data showed increasing amounts of atmospheric carbon dioxide since the industrial revolution began in mid 1800's.



In 1850, the carbon dioxide levels were only 280 ppm.

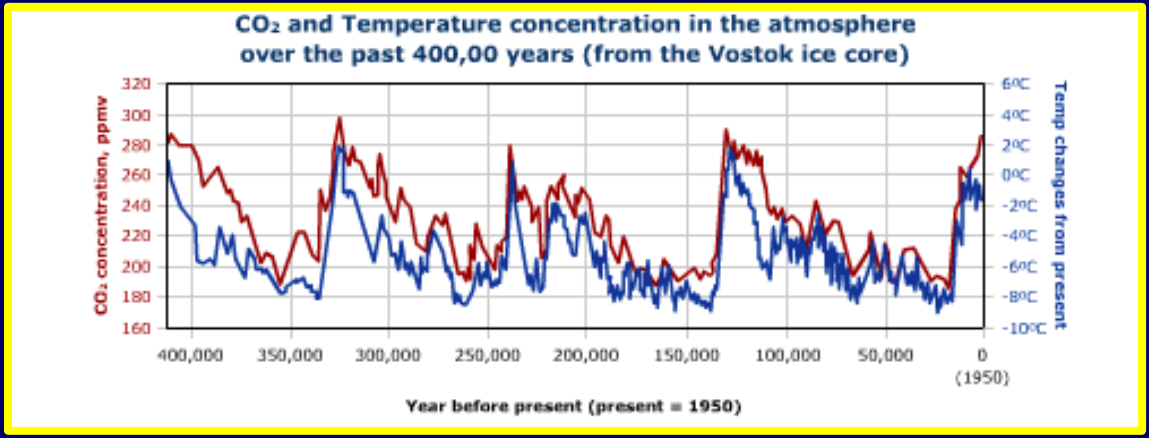
Temperature and Carbon Dioxide

While examining ancient temperatures and carbon dioxide levels, scientists found a correlation between rising carbon dioxide levels and rising temperatures.



Temperature and Carbon Dioxide

The rising temperatures and carbon dioxide levels also correlated with the periodic change in ice ages.

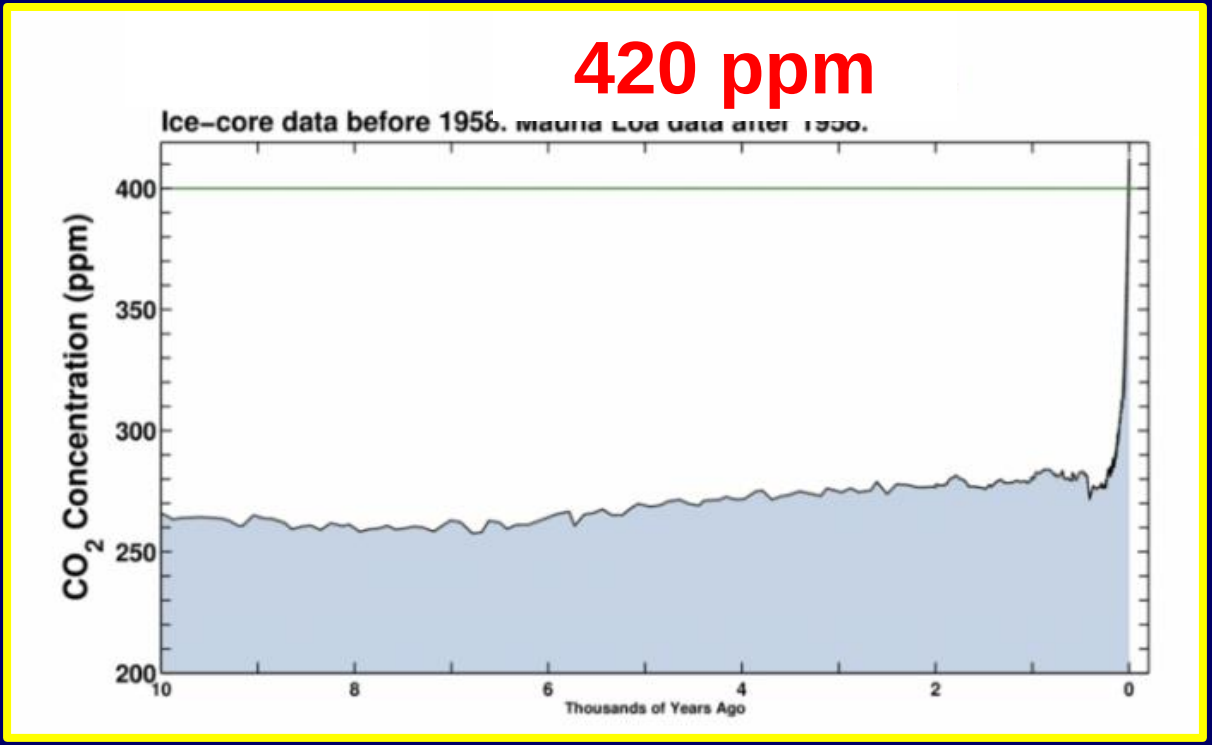


During high glaciation periods, more land and ocean was covered by ice.

So, there was less photosynthesis removing carbon dioxide from the atmosphere. As a result, the increased levels of carbon dioxide would cause warming trends that would melt the glaciers.

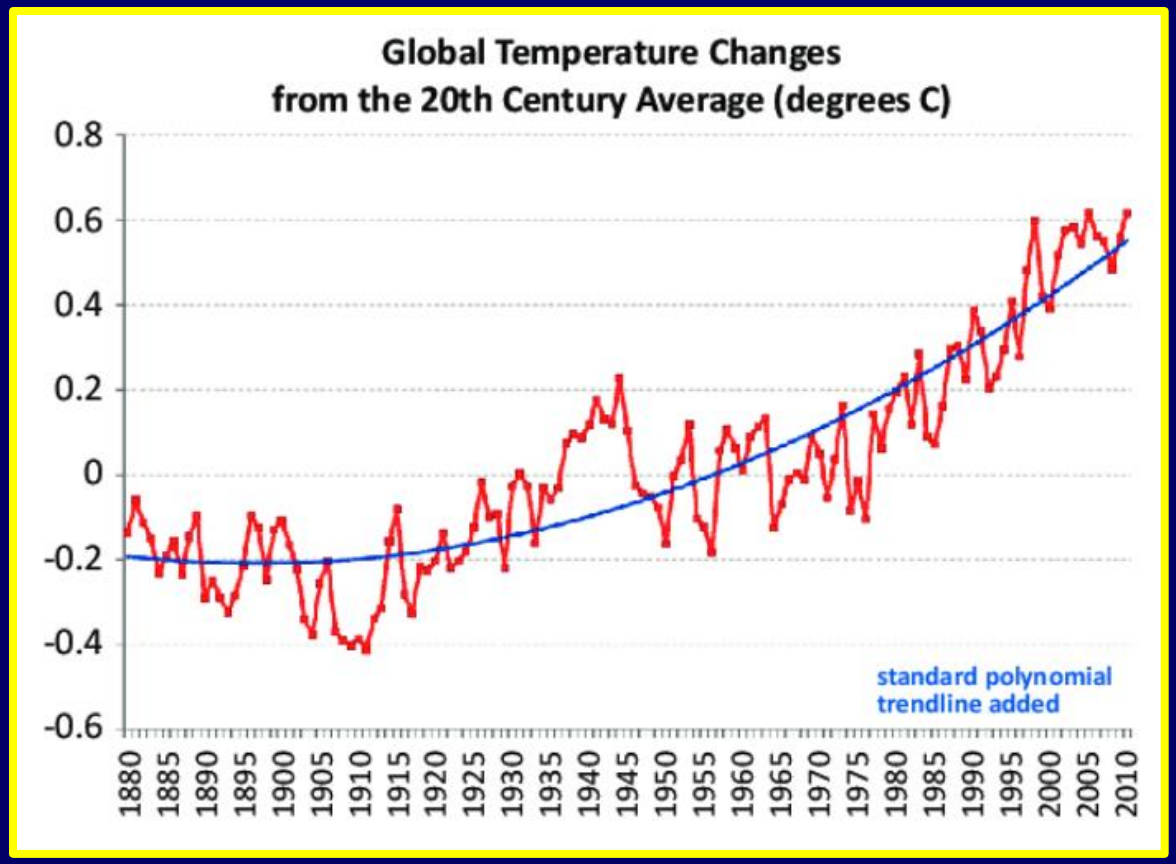
Temperature and Carbon Dioxide

While the data from ancient atmospheres show periodic increases in temperature and carbon dioxide are natural, the levels of carbon dioxide being recorded today are higher than they have ever been in recorded history.



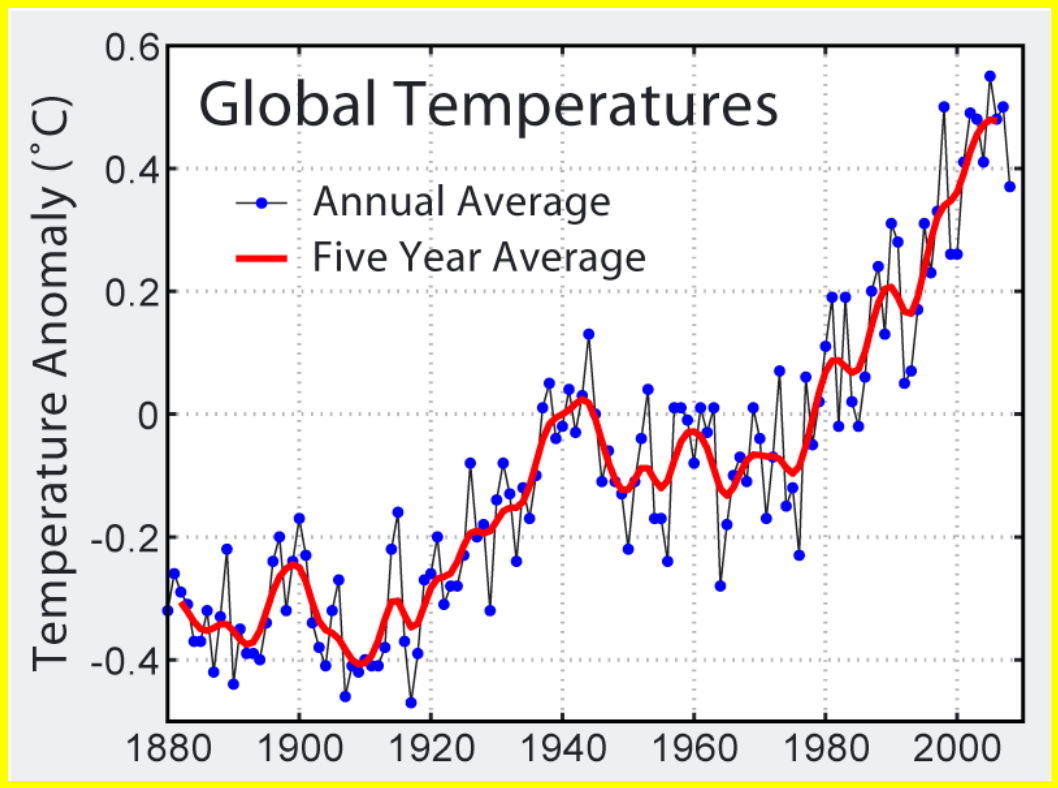
Temperature and Carbon Dioxide

There has also been an increase in the average global temperature with the rate of increase doubling within the last 50 years.



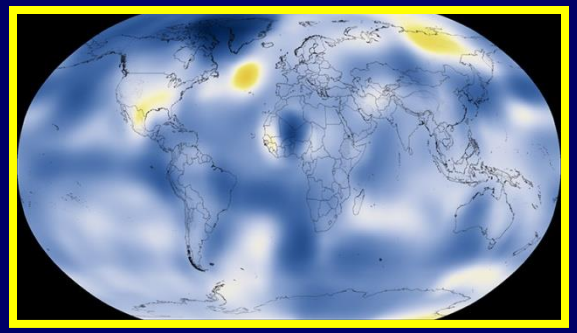
Global Climate Change

Since the early 1900's, there has been a 1^0 F increase in the average global temperature with the 10 warmest years all occurring since the year 2000.

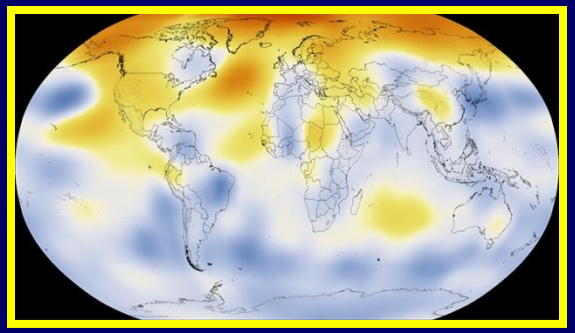


This is a change in the average global temperature.

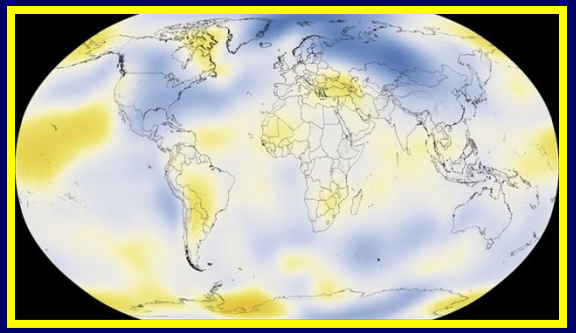
Some places have experienced cooling, other places have experienced warming.



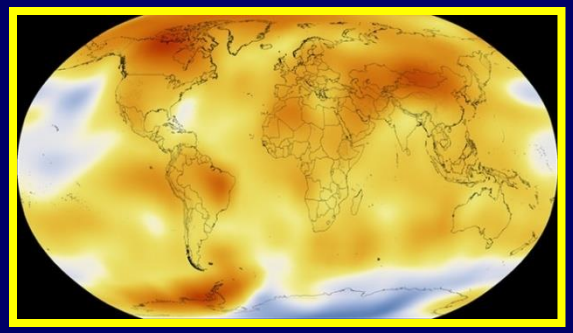
1910 31^0 F



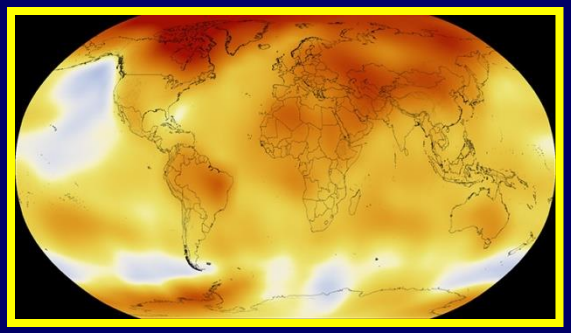
1940 32^0 F



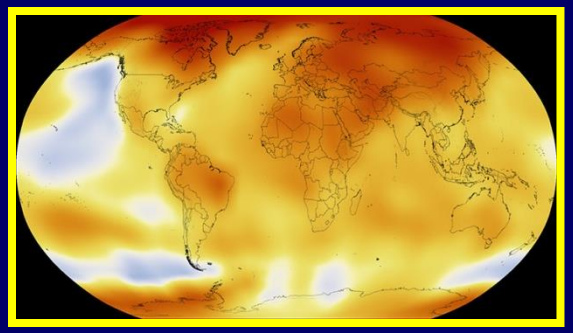
1970 32^0 F



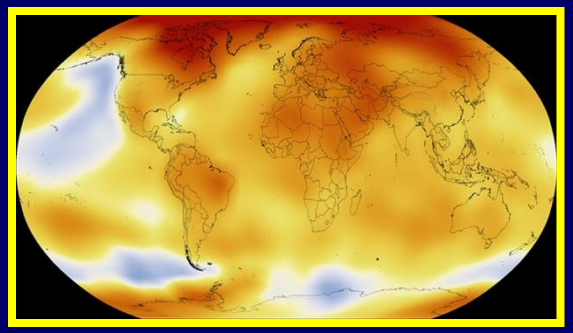
2000 32^0 F



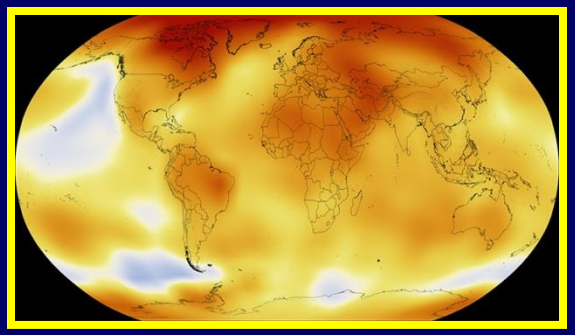
2010 33.2^0 F



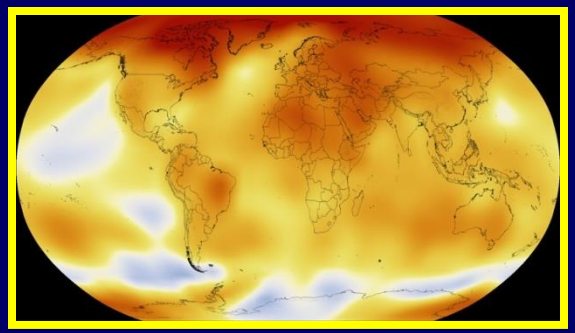
2011 33^0 F



2012 33^0 F



2013 33.1^0 F



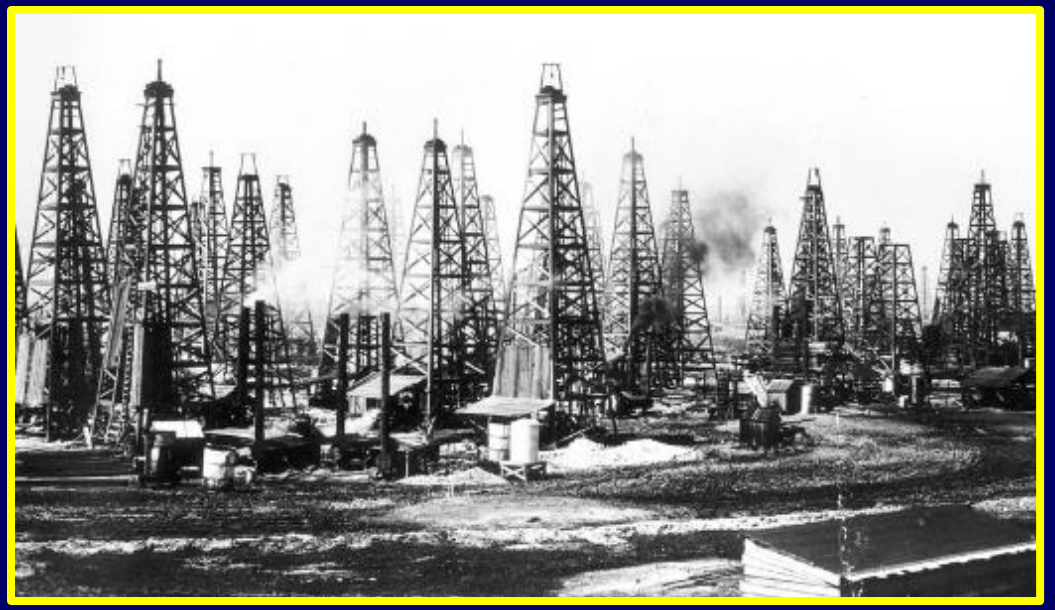
2014 33.2^0 F

Blue = Areas cooler than average

Red = Areas warmer than average

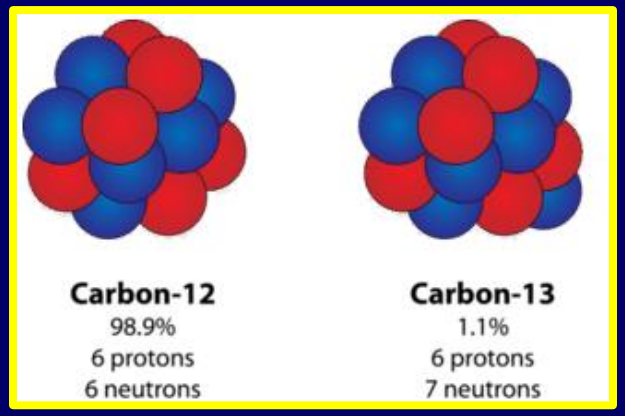
Human Activities or Natural?

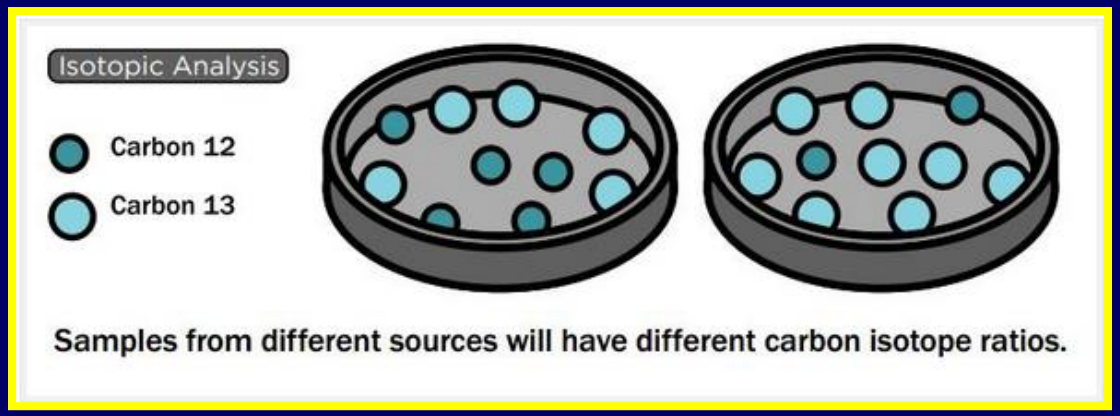
The extraction of fossil fuels is a large money-making industry and very careful accounting methods let us know exactly how much fossil fuels have been extracted and combusted since the industrial revolution.



Human Activities or Natural?

Another method to determine whether the carbon dioxide in the atmosphere is from human activities or natural events is by examining the ratio of carbon isotopes, especially carbon-12 to carbon-13.





Different sources of carbon dioxide emissions will have different carbon isotope ratios, so scientists can determine the sources of CO_2 in the atmosphere.

Scientific Consensus

97% of climate scientists agree there is a global warming trend and that it is due to human activities.

American Association for the Advancement of Science

"The scientific evidence is clear: global climate change caused by human activities is occurring now, and it is a growing threat to society." (2006)

American Chemical Society

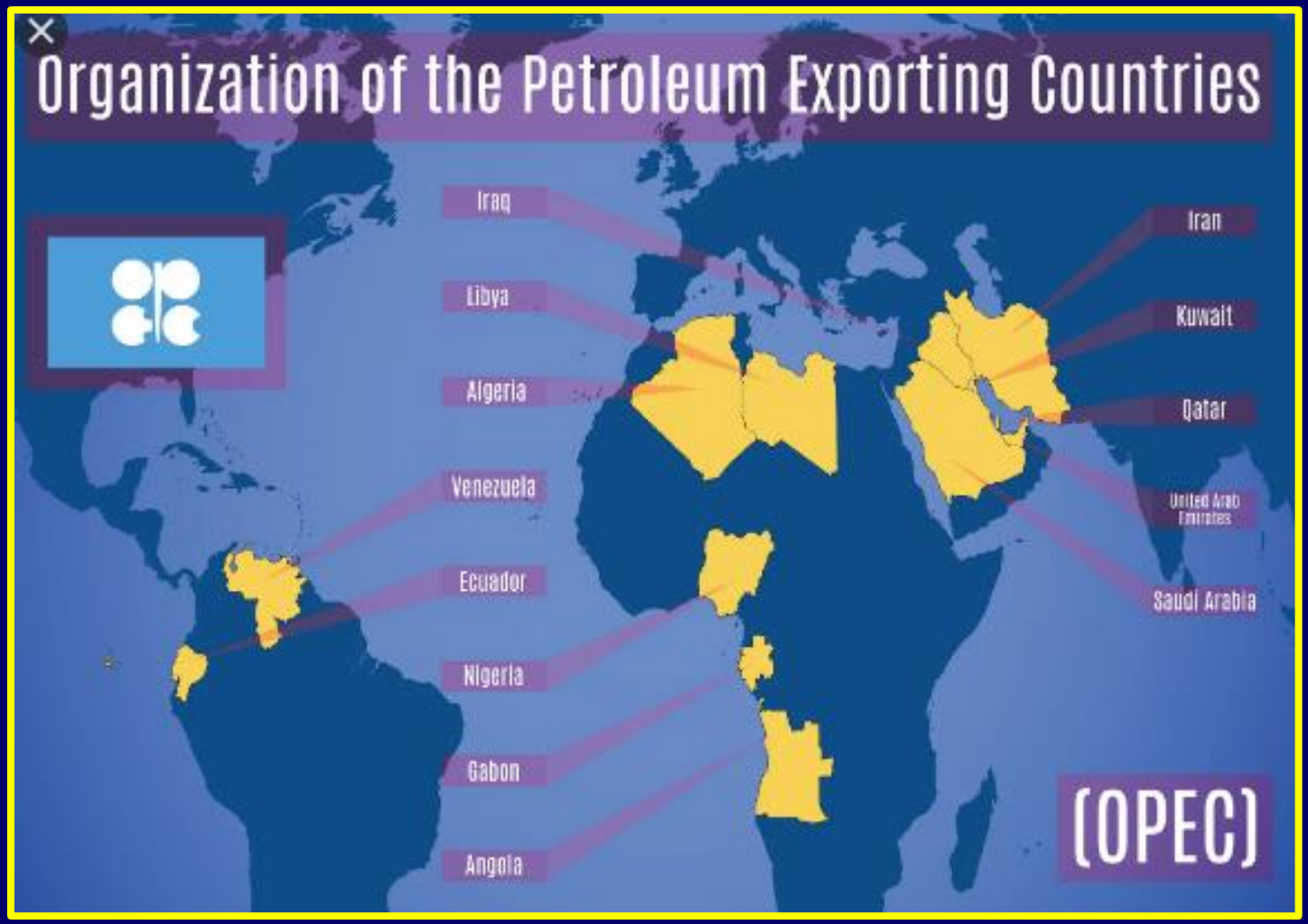
"Comprehensive scientific assessments of our current and potential future climates clearly indicate that climate change is real, largely attributable to emissions from human activities, and potentially a very serious problem." (2004)

Controversy?

The fossil fuel industry is a large money-making industry that not only earns money for the people who own or work for the companies but also for people who buy stock in the company.

Controversy?

Oil is also some nation's main source of income.



Controversy?

All the people who have a financial interest in fossil fuels contribute to campaigns of politicians that agree to vote in favor of the fossil fuel industry.

The fossil fuel industry also creates and funds large organizations that's main purpose is to influence politicians and spread controversial, often inaccurate, information about global climate change.

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The End