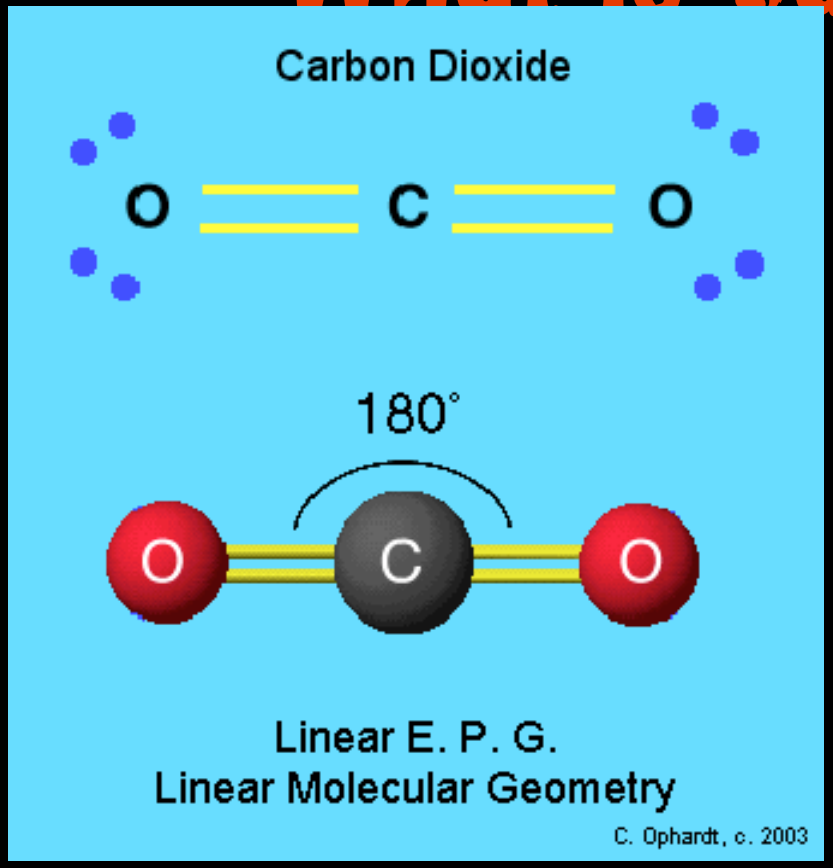
The Magic and Dangers of Carbon Dioxide

What is Carbon Dioxide?



Carbon dioxide (CO_2) is a molecule consisting of one carbon atom covalently double bonded to two oxygen atoms.

Some properties:

-It exists as a colorless, odorless gas at standard temperature and pressure.

-It is a nonpolar molecule.

-It is soluble in water.

Uses of Carbon Dioxide

Commercial Uses:

Carbonation of drinks
Food preparation
Pressurized gas systems
Fire Extinguishers
Lasers
Polymers and Plastics
Refrigerants

Biological Uses and Environmental appearances:

Photosynthesis
Earth's Atmosphere
Cave Formations

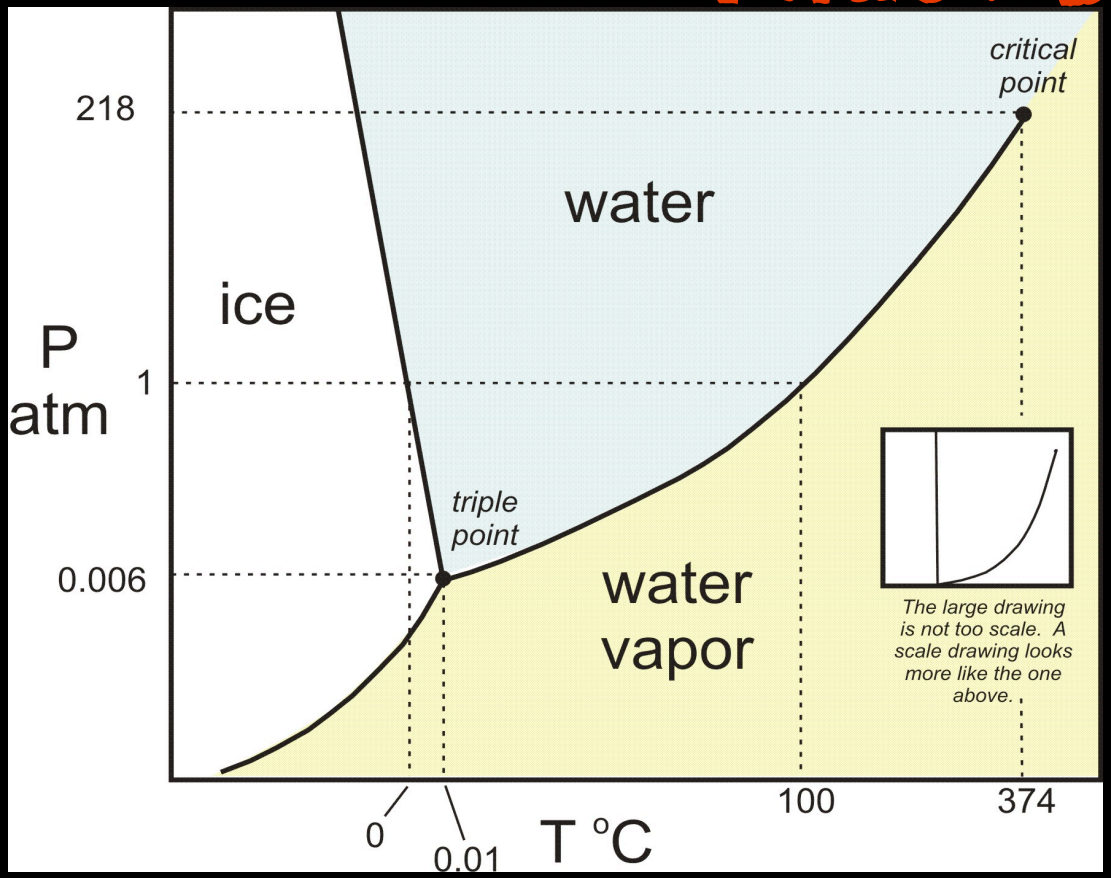
Dry Ice

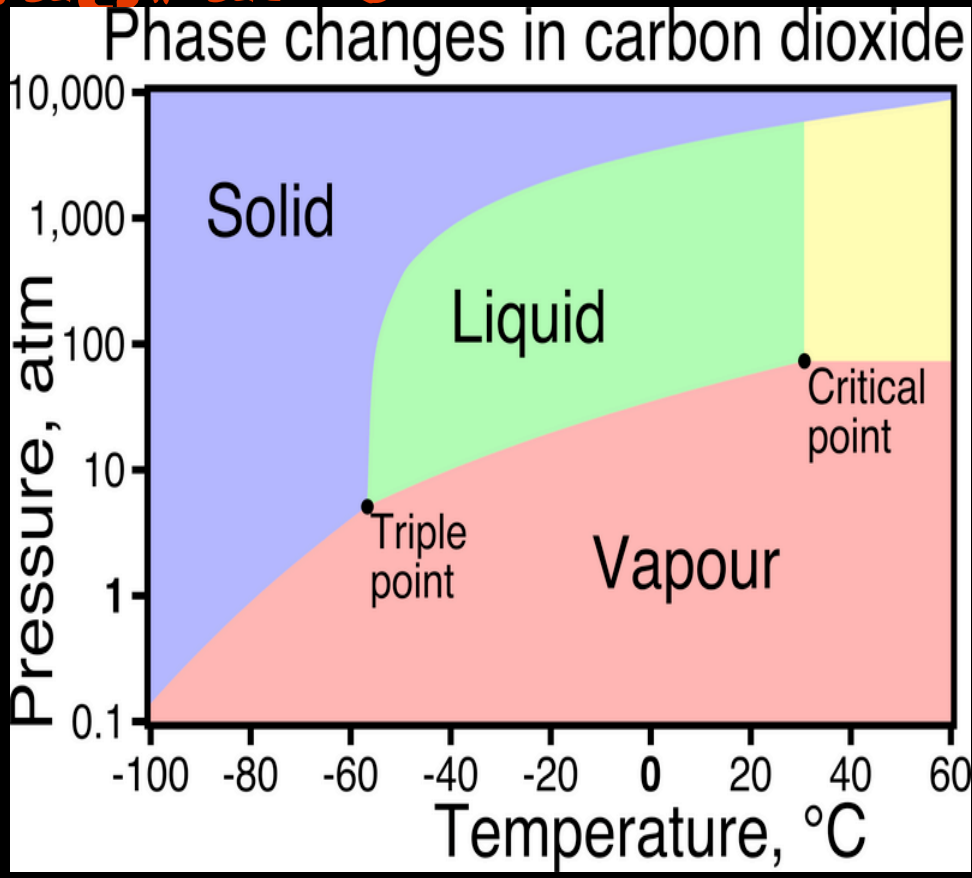
At temperatures below -78°C, carbon dioxide will deposit directly to a solid while it will sublime directly to a gas at higher temperatures. Liquid carbon dioxide cannot be obtained at pressures below 5.1 atmospheres.

-Dry Ice + Water = Carbon dioxide mixed with water vapor

-Denser than air, so it sinks to ground

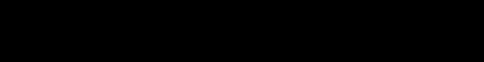
Phase Diagrams

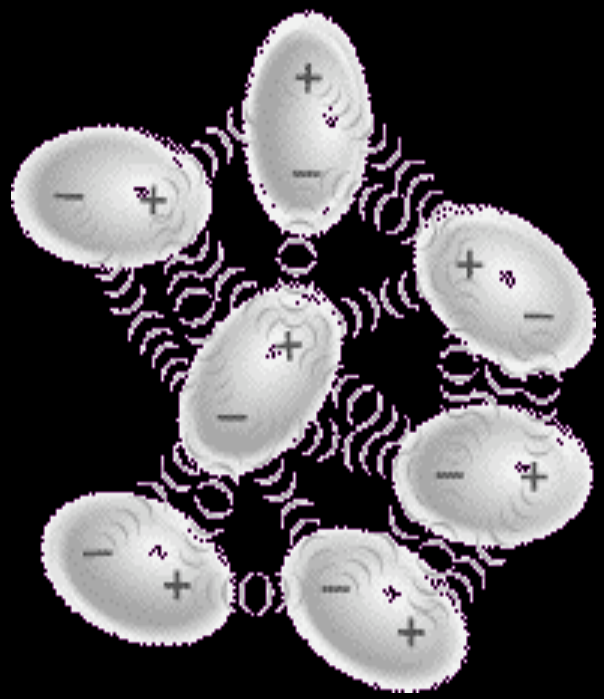




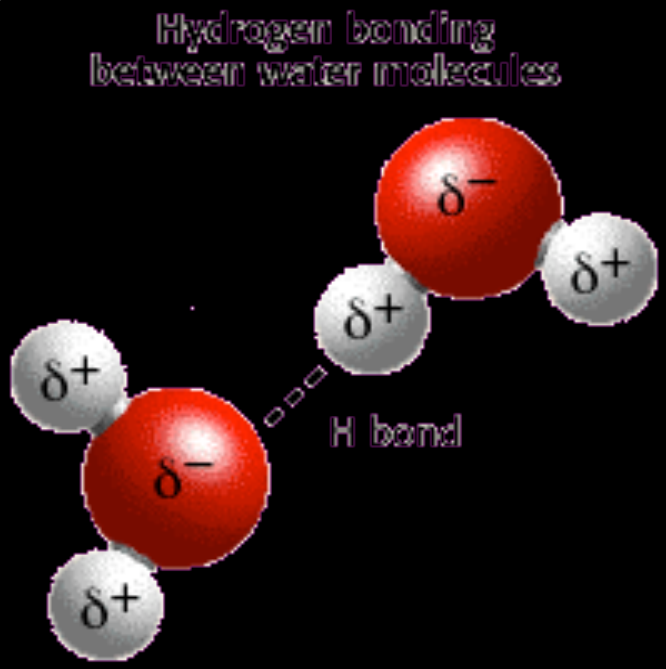
As you probably already know, there are three states of matter: gas, liquid, and solid. A phase diagram functions as a graph that indicates the state of matter that a certain compound will exist in under any given temperature and pressure.

Intermolecular Forces





-Forces between molecules. Not bonds.
-Three types: Dispersion (London) forces, dipole-dipole interactions, and hydrogen bonding
-Dispersion < dipole-dipole < hydrogen bonds
-Determines properties of a compound



Carbonation

As you probably already know, many of your favorite sodas are carbonated beverages. Carbonation occurs when carbon dioxide is dissolved in an aqueous solution. When the soda fizzes, what you're observing is the CO2 gas escaping; a process called effervescence.

In the classic Mentos and Coke experiment, we can observe the presence of the gas through pressure. The mint is riddled with tiny holes that cause the CO2 molecules to clump together and release rapidly. This results in an increase in pressure and a fountain of soda.

Reaction with Water

Carbon dioxide is known as an acid anhydride because when it is added to water, a chemical reaction produces carbonic acid according to the following formula:

$$CO2 + H2O \rightleftharpoons H2CO3$$

Stalagmites and stalactites you often see in caves are the result of this reaction with water. The limestone forming the caves contains calcium; when water containing carbonic acid seeps into the cave, the calcium reacts to form the calcium carbonate forming these structures.

Using Dry Ice to Understand Pressure

Pressure is defined to be the force per unit area exerted on an object. For an ideal gas, the pressure exerted by that gas on a container is related to the amount of gas, the temperature, and the volume of the container and is calculated by the ideal gas law:

$$p = \frac{nRT}{V}$$

Using Dry Ice to Understand Pressure

What if we put a piece of dry ice in a balloon filled with some water?

What if we create a layer of soap over a bucket containing water and dry ice?

What if we drop a piece of dry ice into a bottle filled with water and put the cap on?

What if we press a warm spoon firmly on a piece of dry ice?

Hero's Engine

Also known as an aeolipile, Hero's Engine refers to a vessel allowed to rotate on its axis with openings to allow for expulsion of some gas usually steam. The expulsion results in a thrust that causes the vessel to spin.

http://www.youtube.com/watch?v=szGPVvZoI-I

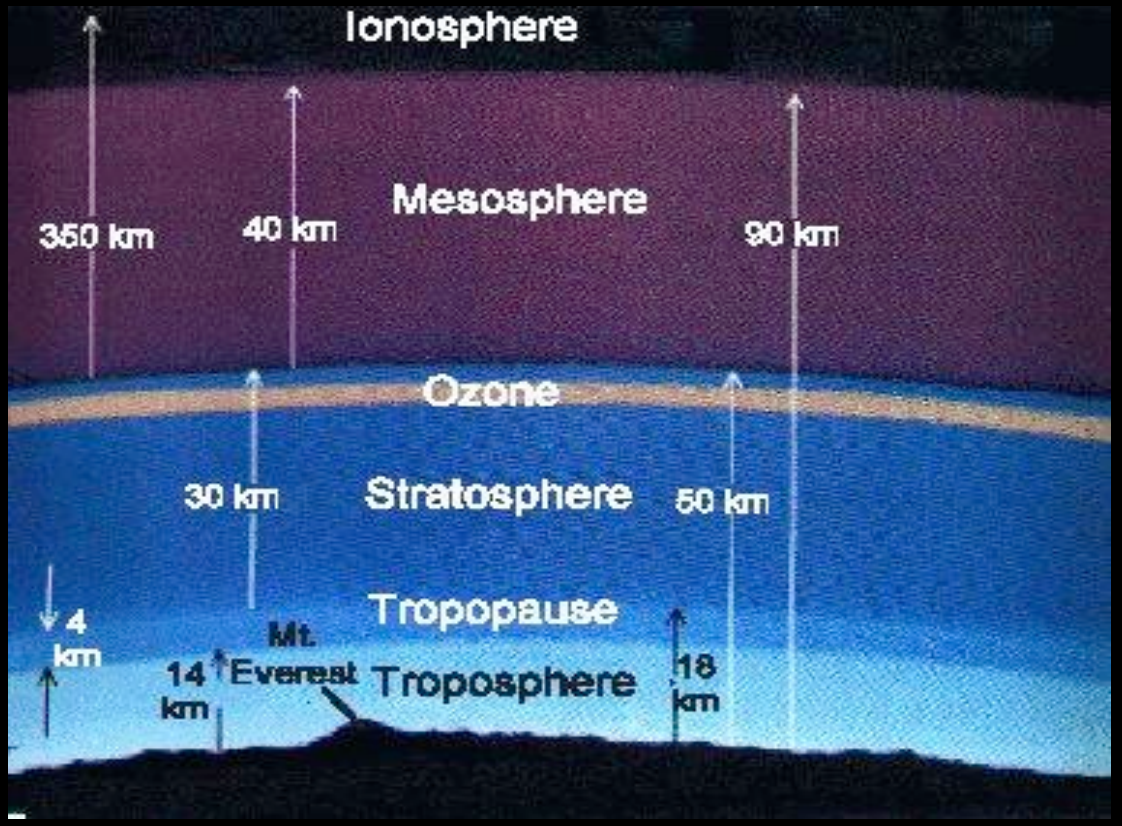
Gases! How many do you know!

http://www.youtube.com/watch?v=HIXEzj08MwE

http://www.youtube.com/watch?v=t6ZTHuDi1Go&feature=related

What about gases found in our atmosphere?

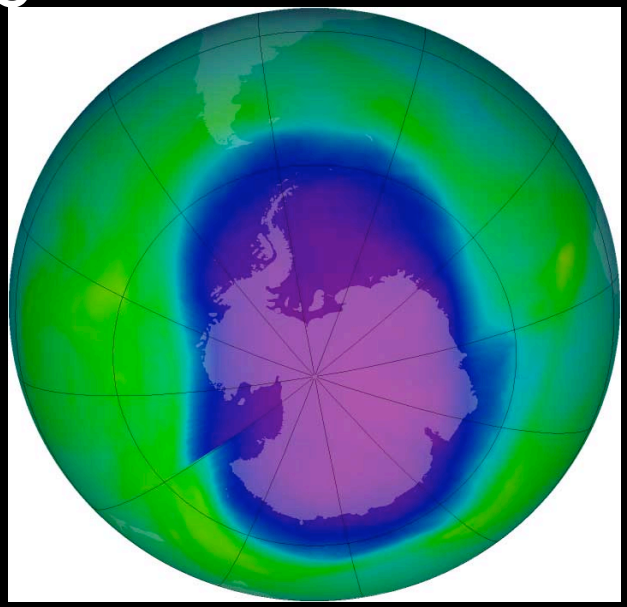
Earth's Atmosphere



The Earth's atmosphere consists, from the ground up, of the troposphere (which includes the planetary boundary layer), stratosphere, mesosphere, thermosphere (which contains the ionosphere and exosphere) and also the magnetosphere. Each layer differs by temperature, pressure, and chemical composition.

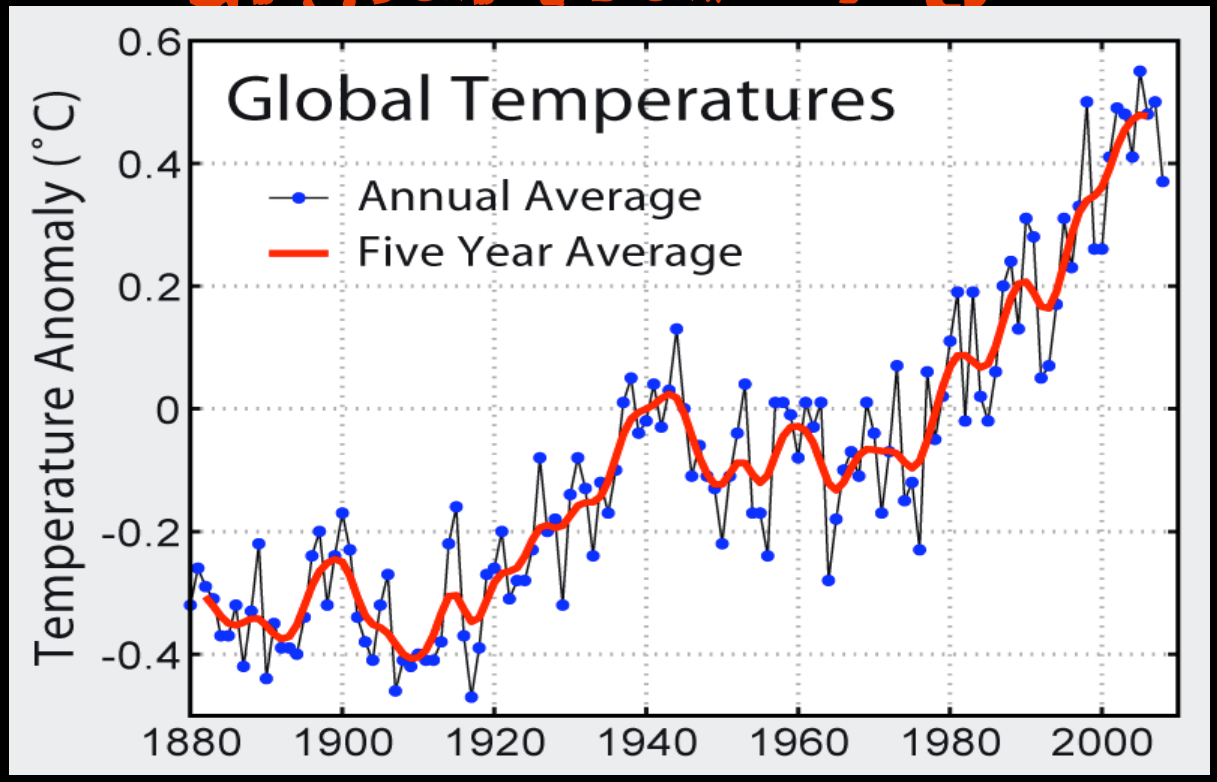
Ozone

Ozone is a triatomic molecule, consisting of three oxygen molecules covalently bonded. It is a polar molecule that is harmful to living organisms



-Concentrations of ozone form a layer in the stratosphere known as the ozone layer.
-Ozone filters out photons from ultraviolet light that are harmful to organisms in large doses.
-Chlorofluorocarbons (CFCs) have resulted in ozone depletion

Global Warming



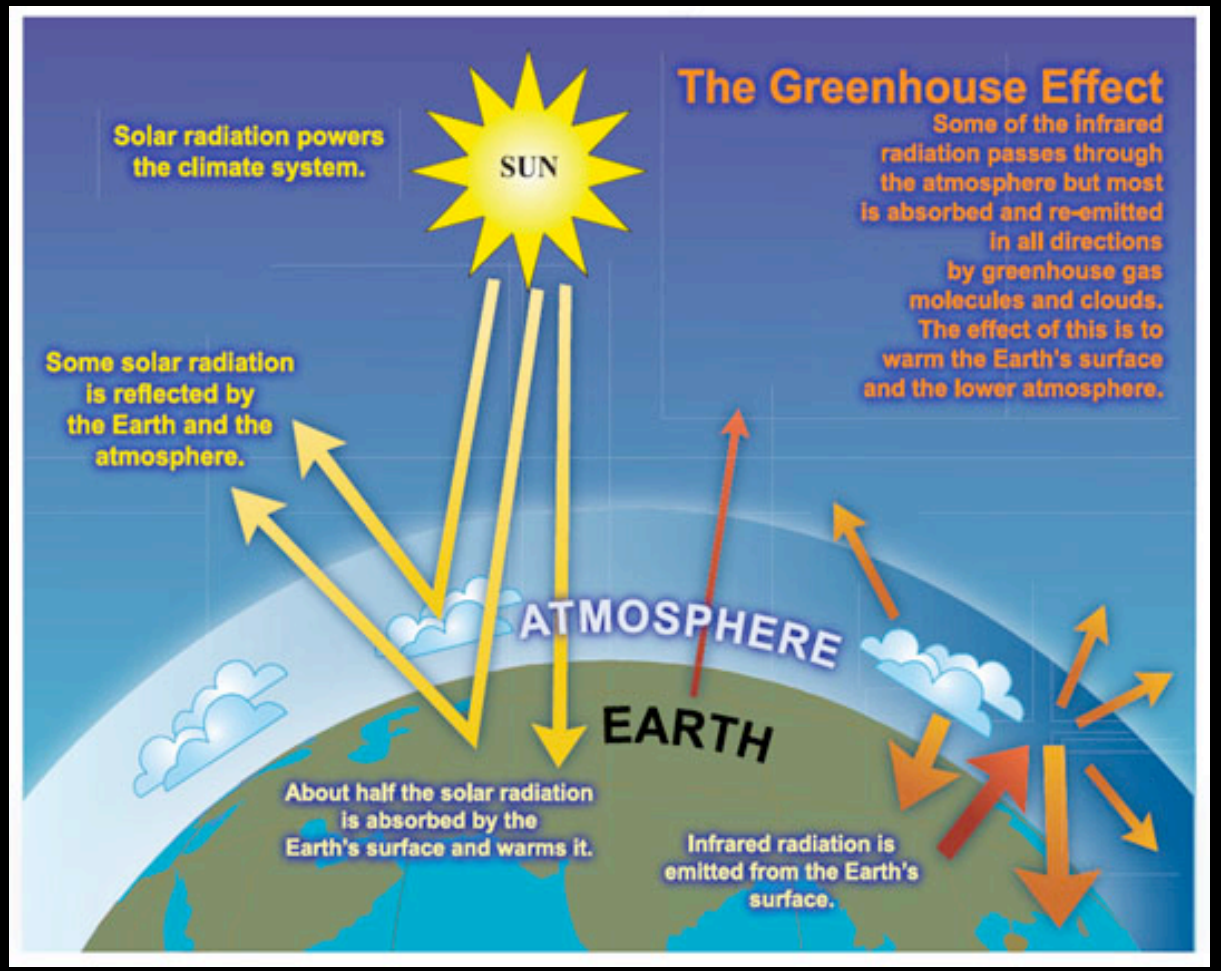
Global warming refers to the increase in the average temperature of the Earth's near-surface air and the oceans since the mid-twentieth century and its projected continuation. Two possible causes include an increase in greenhouse gases and ozone depletion.

Greenhouse Effect

The greenhouse effect is the process by which absorption and emission of infrared radiation by atmospheric gases warm a planet's lower atmosphere and surface.

Major greenhouse gases:

- water vapor
- carbon dioxide (CO_2)
- methane (CH_4)
- ozone



The Problem

Human activity

- increase in the amount of greenhouse gases in the atmosphere
- concentrations of CO2 and methane have increased by 36% and 148% respectively since the mid-1700s.

http://www.youtube.com/watch?v=0XMn_Ry3z6M

Possible Effects

Global warming is expected to cause changes in the overall distribution and intensity of events, such as changes to the frequency and intensity of extreme weather.

-Change in precipitation could lead to drought and flooding
-Glacial retreat
-Arctic shrinkage
-Sea level rising
-Species extinction
-Increase in range of disease vectors

Solutions?

Now it's your turn!
Can you think of any biological, chemical, environmental, or industrial solutions to the hypothesized problem of global warming?

In fact, you could earn some money: http://www.associatedcontent.com/article/146603/richard_branson_ups_ante_with_global.html