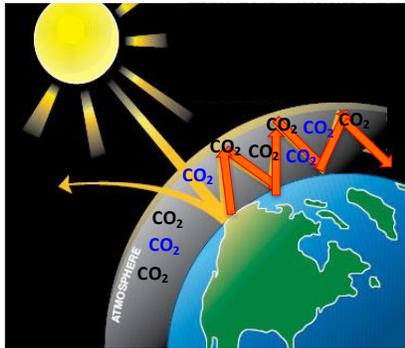


Activity 3.2 The Greenhouse Effect Reading

The Greenhouse Effect

Just as the composition of your clothing affects the movement of heat energy away from your body into the surrounding air, the composition of the atmosphere affects how the temperature of the earth is regulated. The temperature of our air depends on the balance

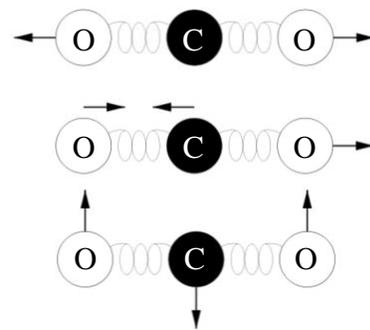


between solar radiation (mostly visible light) that warms the Earth up and invisible infrared (IR) radiation that cools the Earth down by leaving the Earth and going into outer space. The gases in the atmosphere mostly let solar radiation pass right through, but the story about how they interact with infrared radiation is more complicated—and that's a story we need to tell.

Greenhouse Gases

Most of the atmosphere is comprised of nitrogen gas (N₂) and oxygen gas (O₂), but these gases do not change the rate at which energy moves from the surface of the earth into space. On the other hand, some gases like carbon dioxide (CO₂) affect how energy (in the form of infrared radiation) is able to move from the earth's surface into space. These kinds of gases are called *greenhouse gases* because like a greenhouse or a car on a hot summer day, they allow visible light radiation to enter, but slow the loss of leaving infrared radiation.

So why do some gases slow the loss of heat in the atmosphere while others don't? Some molecules absorb infrared light by converting the light energy into the energy of vibration. Molecules with more than two atoms and those with different kinds of atoms can vibrate in multiple kinds of ways, allowing them to absorb and re-emit infrared radiation. Whether or not a molecule can interact with infrared radiation leaving the Earth depends on these vibrations. The atoms on N₂ and O₂ molecules are identical and can only move closer or further apart. This is not complex enough to enable interaction with infrared radiation. Conversely, there are multiple kinds of atoms on a CO₂ molecule, and they have complex vibrational modes. This allows CO₂ to absorb infrared light and emit it in any direction. This slows the loss of this energy from the earth's atmosphere. Increasing the levels of greenhouse gases that exist in the atmosphere makes it more difficult for infrared radiation to leave the earth (similar to the effect of slowly closing car windows on a sunny day).

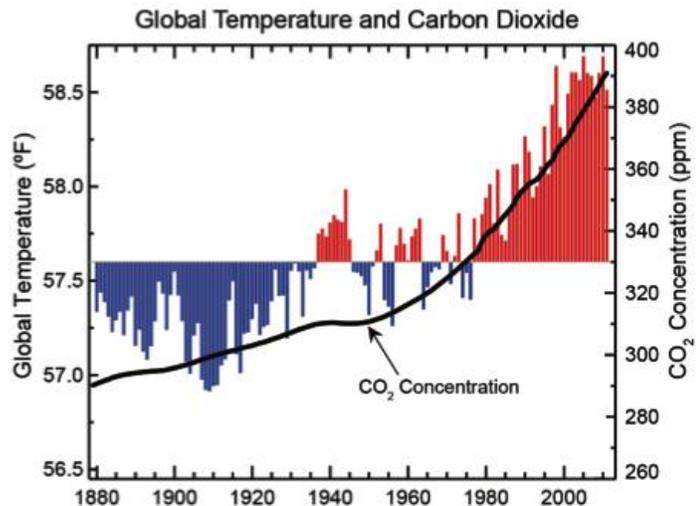


The atoms on a CO₂ molecule have more complex vibration modes that allow them to absorb infrared light and emit it in any direction. (Source: scied.ucar.edu)

Connecting the Keeling Curve to the Greenhouse Effect

This naturally-occurring phenomenon is called the *greenhouse effect* and is necessary for life on Earth. Without greenhouse gases the Earth would be freezing cold! However, if the concentration of greenhouse gases in the atmosphere increases *too much*, it will cause the planet to reach temperatures that damage our ecosystems. Just like leaving a car's windows closed on a hot summer day can cause the temperature inside the car to rise, increasing the concentration of CO₂ and other greenhouse gases in the atmosphere can cause the temperature of the planet to increase.

Dr. Charles Keeling was the first person in the world to accurately determine the rate at which carbon dioxide in the air was gradually increasing each year. More CO₂ absorbs more infrared radiation, so the average temperature of the Earth is increasing. There are still hot places and cold places, and there are still hot days and cold days, but as the graphs shows, the Earth's overall average temperature has been increasing for more than 100 years.



Source: 2013 Draft National Climate Assessment