PURDUE EXTENSION

Human Activity and the Greenhouse Effect

What greenhouse gases do humans generate?

Every day we generate greenhouse gases through interaction with factories, agriculture, and cars. Our activities produce four major greenhouse gases (Figure 1).

Carbon dioxide (CO2)

Carbon dioxide enters the atmosphere through burning fossil fuels (i.e., coal, natural gas, and oil), solid waste, trees, and wood products. Certain chemical reactions (e.g., manufacturing cement) can also generate carbon dioxide. Carbon dioxide is removed from the atmosphere (sequestered) when it is absorbed by plants as part of the biological carbon cycle.

Methane (CH4)

Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural activity and by the decay of organic waste in municipal solid-waste landfills.

Nitrous oxide (N2O)

Nitrous oxide is produced naturally in soil, and thus is emitted during agricultural practices. Industrial sources, as well as burning fossil fuels in internal combustion engines, produce nitrous oxide.

Fluorinated gases

Hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride are synthetic, powerful greenhouse gases that result from a variety of industrial processes. These gases are typically emitted in smaller quantities than the gases above, but have a high global warming potential because they trap and hold more radiant heat than the other greenhouse gases.

What human activity creates the most greenhouse gas emissions?

As of 2014, electricity production generates the largest share of greenhouse gas emissions, making up 30% of emissions (Figure 2). Approximately 67% of our electricity comes from burning fossil fuels, mostly coal and natural gas.

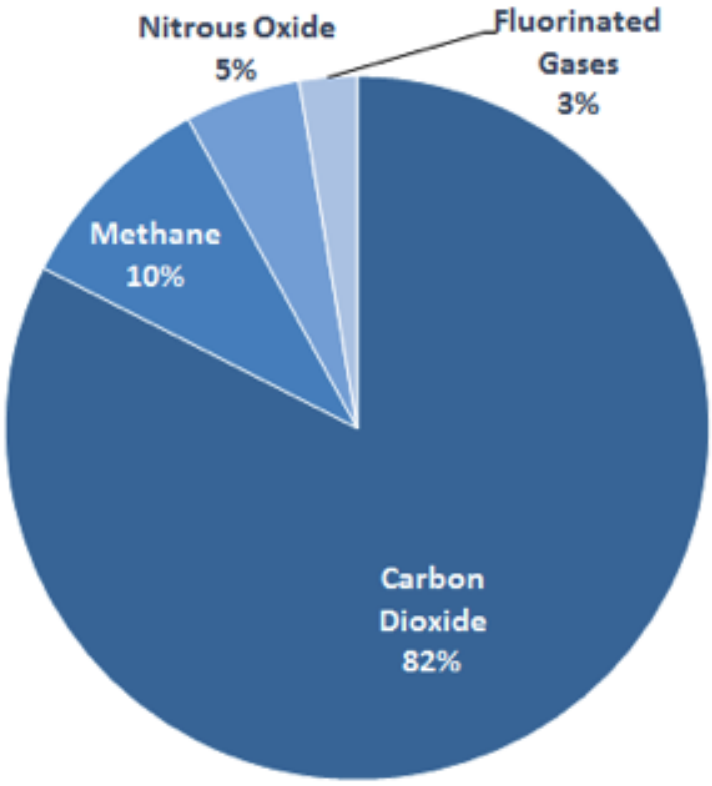

Figure 1: United States greenhouse gas emissions in 2014. Source: https://www.epa.gov/ghgemissions/overview-greenhouse-gases

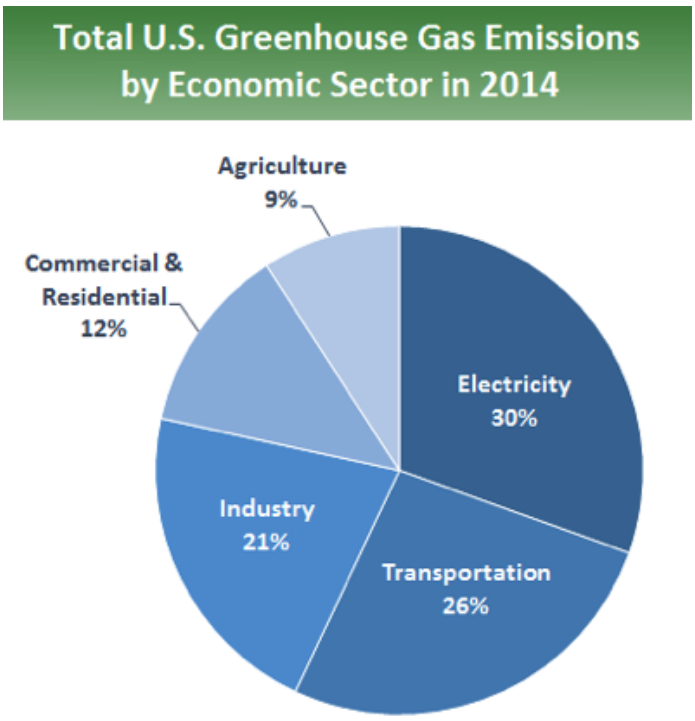

Figure 2: Total U.S. greenhouse gas emissions by economic sector. Source: https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions

What are other sources of human greenhouse gas emissions?

Other economic sectors that generated a significant portion of greenhouse gas emissions in the United States in 2014 include transportation (26%) and industry (21%). Emissions from transportation primarily come from burning fossil fuels in cars, trucks, ships, trains, and planes. Emissions from industry primarily come from burning fossil fuels for energy, as well as from certain chemical reactions necessary to produce goods from raw materials. Commercial and residential properties (i.e., businesses and homes) generated 12% of emissions and agriculture generated 9% of US emissions in 2014.

How do increased greenhouse gases in the atmosphere lead to warmer temperatures?

Greenhouse gases absorb and reemit radiant heat energy from the sun. They hold onto that heat energy for a much longer period of time than do other atmospheric gases.

Water vapor is the Earth's most important natural greenhouse gas. Water vapor and clouds cause most of the Earth's natural greenhouse effect and account for about 90% of the total heat-retaining capacity of the atmosphere. Greenhouse gases can also reabsorb solar radiation reflected or reemitted from Earth's surface, trapping the heat in our atmosphere instead of letting it escape to space.

The Greenhouse Effect is a natural process essential for life on Earth, because it plays an important role in regulating the Earth's temperature. However, over the last several hundred years, humans have been increasing the atmospheric concentration of greenhouse gases (mainly carbon dioxide and methane) above the natural amount, which has led to increased warming.

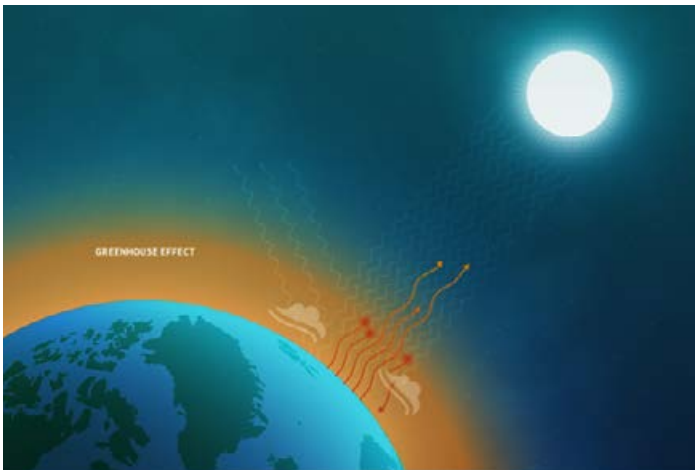

Figure 3: Diagram depicting the Greenhouse Effect. The arrows represent radiant energy from the sun entering and leaving Earth's atmosphere. Source: http://epa.gov/climatechange/science/causes.html

What evidence do scientists have that human emission of greenhouse gases is contributing to global warming?

In 1859, John Tyndall's laboratory experiments showed that complex molecules could absorb thermal radiation. He noted that changes in the amount of water (H2O) or carbon dioxide (CO2) in the atmosphere could be responsible for all known fluctuations of the climate system. In 1895, Svante Arrhenius followed Tyndall's work with a climate prediction based on greenhouse gases, suggesting that a 40% increase or decrease in the amount of CO2 might trigger glacial advances and retreats.

G.S. Callendar in 1938 solved a set of equations linking greenhouse gases and climate change. He found that doubling the atmospheric CO2 concentration resulted in a 2°C increase in the mean global temperature with considerably more warming at the poles. He linked increasing fossil fuel combustion with a rise in CO2 and its greenhouse effects. Historic atmospheric measurements of Earth's CO2 content showed that temperatures rose directly with the observed increases in CO2. These observations have helped to firmly establish that CO2 is an important driver of climate change

What is the relationship between temperature and carbon dioxide in past climate?

Recent and historical observations show that temperature and carbon dioxide levels show a strong correlation with one another. When the carbon dioxide concentration goes up, temperature goes up, and vice versa. Figure 4 shows the temperature change (blue) and carbon dioxide change (red) observed in ice core records.

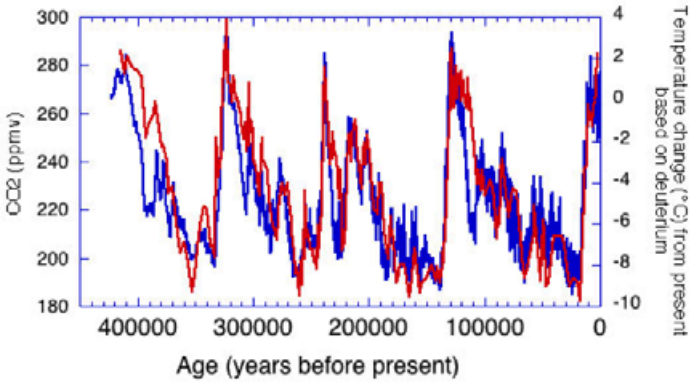

Figure 4: Temperature change (blue) and carbon dioxide change (red) observed in ice core records.
Source: http://www.ncdc.noaa.gov/paleo/globalwarming/temperature-change.html

Resources

Intergovernmental Panel on Climate Change, 2007. Climate Change 2007: Working Group I: They Physical Science Basis. http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch1s1-4.html#1-4-1

Stanford SOLAR Center, 2008. Global Warming. http://solar-center.stanford.edu/sun-on-earth/glob-warm.html

US Environmental Protection Agency, 2017. Source of Greenhouse Gas Emissions. https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions

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