

What Causes Climate Change?

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This article is the second of five in a [series](#) to understand the basic science of climate change. In this article, we explore the causes of climate change.

Despite a vocal minority of [climate deniers](#), there is no reasonable doubt that the climate is changing, and that the change is the result of human activity. But climate science is complicated, and few adults learned about it in school. If you do not understand climate change as well as you'd like, let this be your introduction to a basic understanding of climate science. Welcome to Climate Change 101.

What Is Climate Change?

As explained in the [first article in this series](#), climate change is the environmental crisis created by greenhouse gases released into the atmosphere by human industrial activity. The concentration of carbon dioxide (CO₂) in the atmosphere has increased from about [280 parts per million](#) in the 1800s to more than 415 parts per million today and is still [increasing rapidly](#).

Climate change is an environmental crisis because humans evolved and societies grew during a long cool era in Earth's history that has ended because our industrial emissions drove average global temperatures higher. Humans, not nature, must change their behavior to restore the atmosphere to the state in which we developed as a species. Our survival is at risk.

This increased concentration has intensified the natural [greenhouse effect](#) of the earth's atmosphere. It has raised the global average surface temperature by 3.6 degrees Fahrenheit (2 degrees Celsius) and is causing a cascade of complex shifts to climate patterns. These disruptions result in more frequent and more extreme weather events, redistribution and destruction of wildlife populations, and many other harmful changes.

Greenhouse Gases

There are [many greenhouse gases](#) (GHGs), including methane, nitrous oxide, fluorinated gases, carbon dioxide, and even water vapor. Except for the fluorinated gases (chlorofluorocarbons and hydrofluorocarbons), which are human-made, any of these gases can occur naturally or be generated by human activity.

Each gas has a different ability to trap heat (known as its [global warming potential](#)) and a different lifetime in the atmosphere. Among the GHGs, [water vapor](#) is the most common by volume, and the [fluorinated gases](#) are the [most potent](#), with global warming potentials measured in thousands. However, [carbon dioxide](#) is the most significant to climate change because we are adding so much of it to the atmosphere. And once released, it remains in the atmosphere for a very long time – up to 1,000 years.

Natural Causes of Climate Variability

Baseline quantities of carbon dioxide are generated through [natural processes](#) like ocean-atmosphere exchange; soil, plant, and animal respiration; and decomposition. The atmosphere, like all natural systems, is variable. The concentration of greenhouse gases in the atmosphere naturally fluctuates.

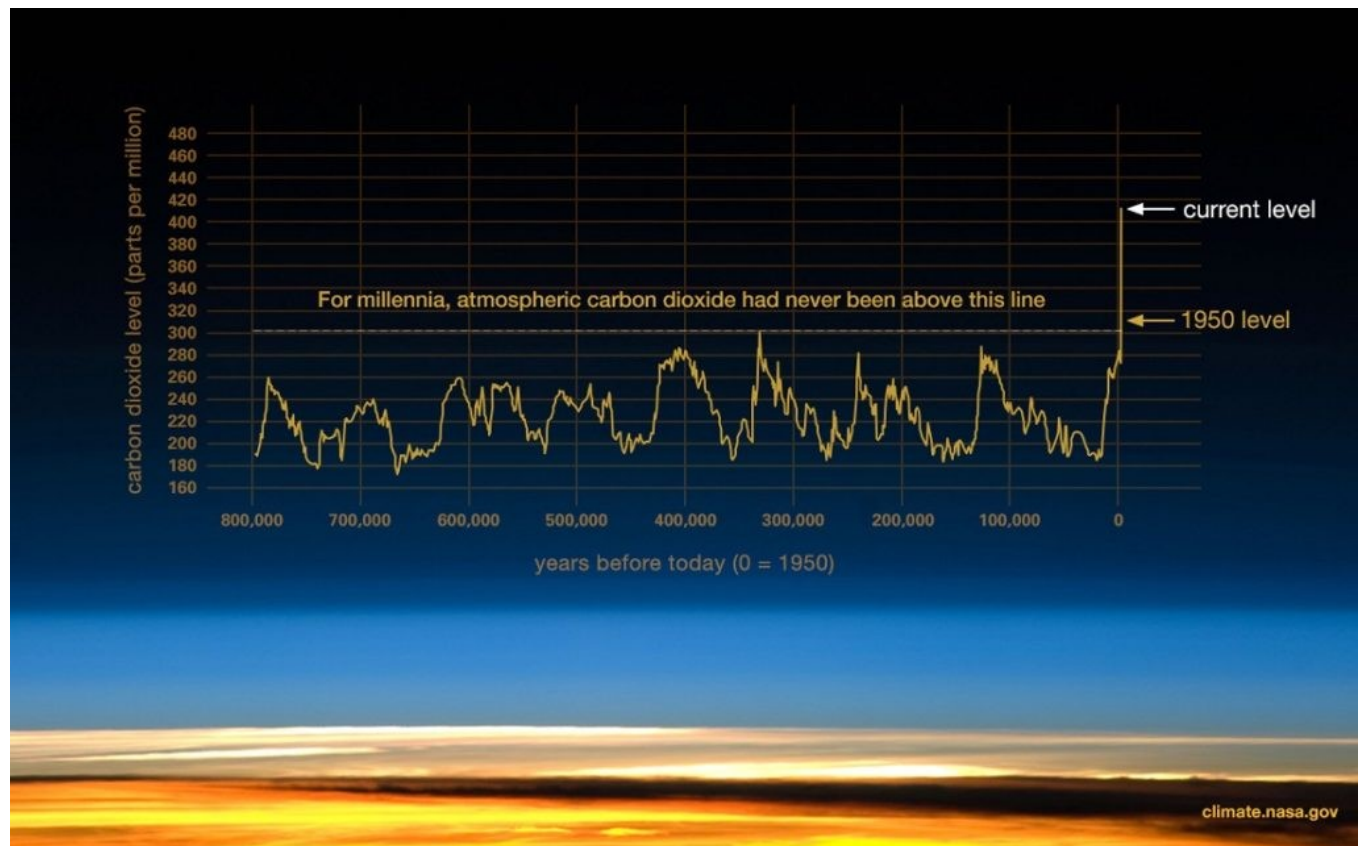
Using ice core samples, scientists can measure [historical concentrations](#) of CO₂ in the air. During the last 400,000 years, the natural variation in atmospheric CO₂ levels was between 200-280 parts per million. Regularly [recurring factors](#) such as the seasons, oceanic cycles, and the solar Schwabe cycle create some of the variation. Irregular occurrences like [volcanic eruptions](#) and large [forest fires](#) can contribute to variations as well.

But all of these sources combined do not account for the changes that have been documented in the last century.

Anthropogenic Greenhouse Gases

Climate change is [anthropogenic](#). Anthropogenic is a big word that simply means “caused by people.” Humans have [increased atmospheric carbon dioxide](#) levels by 45 percent since the beginning of the Industrial Age. Half of that increase has occurred since 1980, and one-quarter since 2000. Methane concentrations have increased 2.5 times in the same time period, with most of the increase occurring since 1980.

Natural cycles and rare natural events combined do not result in such high numbers. But these numbers are consistent with post-industrial emissions levels. In 1950, atmospheric CO₂ levels reached their highest point in 800,000 years, and they have been increasing exponentially since.



This graph provides evidence that atmospheric CO₂ has increased dramatically since the Industrial Age. Image: climate.nasa.gov

But this circumstantial evidence is not the only reason to identify anthropogenic causes for climate change. [According to NASA](#), carbon produced by burning fossil fuels has a different ratio of heavy-to-light carbon atoms, so it leaves a distinct “fingerprint” that instruments can measure. The measured decline in carbon-13 isotopes in the atmosphere indicates that the increased carbon dioxide levels are the result of burning fossil fuels.

We did this to ourselves.

Global Causes of Climate Change

Globally, the top sources of greenhouse gas emissions are:

- Electricity and heat production (25%)
- Agriculture, forestry, and other land uses (24%)
- Industry (21%)

More than half (53 percent) of [global GHG emissions](#) are generated in Asia, where China alone accounts for more than one-quarter of the world’s total. However, Asia houses 60 percent of the world’s population, and much of China’s industrial output is for North American consumption. This puts per capita emissions in Asia slightly below the world average.

American Causes of Climate Change

North Americans, on the other hand, have a very high per capita GHG production. The United States, with only [4.3 percent of the world’s population](#), generates 15 percent of global greenhouse gases. Furthermore, while Asia has only recently become an important contributor to climate change; the U.S. has emitted more total CO₂ than any other country. The United States has released about 400 billion tons total, making it responsible for 25 percent of historical emissions.

Fossil fuel use in the U.S. also follows a slightly different pattern from the rest of the world. Using 2018 data, the EPA estimates [total U.S. GHG emissions](#) by economic sector. Their estimates indicate that transportation generates 28 percent of the GHGs in the U.S. Electricity follows as a close second at 27 percent. Greenhouse gas emissions from transportation overwhelmingly – 90 percent – come from burning gasoline and diesel fuels.

Fortunately, transportation is one area where most individuals have a level of control and can [take measures](#) to reduce their impact.

Most greenhouse gas emissions from generating electricity – about 63 percent – come from power plants that burn coal and natural gas. Individuals usually have less control over their [electricity](#) sources. But there are some actions individuals can take to both green their energy supply and reduce their electricity use.

The third article in this series will deal with the consequences of climate change.

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