

What is carbon dioxide, anyway? How does it cause global warming?

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Chemically, carbon dioxide is incredibly simple—it is just one carbon atom linked with two oxygen atoms. Together they create a colorless gas that makes up just a tiny fraction of the Earth's atmosphere, about 0.04%.

That gas is critical to life on earth because plants use sunlight and [carbon dioxide](#) to create energy through the process of photosynthesis.

But carbon dioxide is also the primary reason the climate is warming, a long-term shift in temperature that threatens the delicately balanced ecosystems humans depend upon.

So how is something so necessary to life also so harmful? Here's what to know:

Why does carbon dioxide cause global warming?

Earth is heated by the sun—About 71% of the [solar energy](#) that arrives is absorbed by the [atmosphere](#) and surface and 29% is reflected back into space, according to NASA.

The energy that comes in from the sun alone is not enough to keep the Earth warm. For that we need the Earth's atmosphere, which acts like a blanket holding in some of the heat, said Scott Denning, a professor of atmospheric science at Colorado State University.

That "blanket" is made up of several gases nicknamed "[greenhouse gases](#)" because they hold in heat, just like the glass panes of a greenhouse hold in the sun's heat.

The [greenhouse effect](#) is a natural process, said Denning. "It's really lucky for us that we have air." Without it, the Earth would just be a white frozen ball hanging in space—uninhabitable.

That [natural process](#), however, has begun to change due to humans burning [fossil fuels](#).

Is carbon dioxide a greenhouse gas?

Earth's atmosphere is made up of 78% nitrogen and 21% oxygen, with

just 1% other things. Greenhouse gases are among those "other things."

Carbon dioxide is a [greenhouse gas](#), one of the four main ones. In terms of US greenhouse gases emissions, here's a list by amounts from the Environmental Protection Agency:

- Carbon dioxide, 79%
- Methane ([natural gas](#)) 11%
- Nitrous Oxide 7%
- Fluorinated gases 3%

What does CO₂ mean?

You'll often see carbon dioxide written with its chemical formula name, CO₂. That simply means it's a molecule that contains one carbon and two [oxygen atoms](#). In chemical texts it's written this way: CO₂ where the subscript numeral two means there are two oxygen atoms.

How does carbon dioxide work as a greenhouse gas?

CO₂ is great at holding in heat partly because it's a bigger molecule than the nitrogen (78%) and oxygen (21%) that make up most of Earth's atmosphere. They are each composed of two, not three, linked atoms, two nitrogens or two oxygens.

That geometry means they only interact with a narrow wavelength of light. The more complex geometry of CO₂ molecules means they can absorb a much wider range of light waves, including the infrared waves that carry heat.

So the more CO₂ molecules in the atmosphere, the more heat they can trap.

It's a delicate balance. Too little CO₂ and the Earth wouldn't stay at a temperature suitable for life. Too much and the temperature starts to rise.

Note that CO₂ is the greenhouse gas that's most discussed because, although it's less powerful than some such as methane (natural gas), it stays in the atmosphere for hundreds and even thousands of years.

Where does carbon dioxide come from?

Carbon dioxide is what people and animals breathe out after breathing in oxygen. But that's balanced by the plants we eat, so humans and animals aren't affecting the balance of atmospheric CO₂. It's a cycle, humans and other animals exhale CO₂ but it's the same carbon that was "inhaled" by the plants we eat, so it doesn't contribute to global warming.

Carbon dioxide in the atmosphere comes from two primary sources, natural and human activities. Natural CO₂ comes from outgassing from the ocean, decomposing plants, wildfires and volcanoes.

Humans began to change the balance of greenhouse gases in the atmosphere around 1750. That's when the Industrial Revolution began in England and factories started burning coal to power machines. This added new carbon dioxide to the atmosphere from fossil fuels that had been buried deep underground for millions of years.

Here's how much the balance has changed: For the last 400,000 years, the amount of CO₂ in the atmosphere fluctuated between 200 and 280 parts per million, according to NASA.

In 1750 the amount of CO₂ in the atmosphere was estimated to be about 280 ppm.

Today, it's risen to 418 parts per million, the highest it's been in 3.6 million years.

As people began burning more fossil fuels, the amounts have increased. According to NASA, half of the increase in atmospheric carbon dioxide concentrations in the last 300 years has occurred since 1980, and one-quarter of it since 2000.

How can such a tiny amount of CO₂ cause so much trouble?

The difference between 280 parts per million and 418 might not seem like a lot, but it means humans have generated an estimated 1.5 trillion tons of carbon dioxide pollution in the last 150 years.

That means the blanket around the Earth has gotten thicker and it's having an effect. Since 1880, the global annual temperature has increased 1.9 degrees, with the majority of the warming occurring since 1975.

A 1.9 degree increase isn't that much, is it?

It takes a lot of energy to warm all the oceans, the atmosphere and the land by almost 2 degrees.

That additional heat is causing weather patterns to become more intense and more erratic.

It's also making things hotter. The past seven years were Earth's warmest on record "by a clear margin," according to new research released this week by the Copernicus Climate Change Service, a group affiliated with the European Union.

Because CO₂ stays in the atmosphere for anywhere from 300 to 1,000

years, the levels aren't going to come down quickly no matter how much humanity cuts production. But if they aren't cut, the temperature will rise even further.

That means 2022 was probably one of the coolest years children alive today will remember.

Are carbon and carbon dioxide the same thing?

They're not. Carbon is a black, solid element while carbon dioxide is a colorless gas.

But when people talk about [climate change](#), they use "carbon" as shorthand for "carbon dioxide." When someone says "carbon neutral" or "carbon free," they're actually talking about reducing the amount of [carbon](#) dioxide that's emitted.

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