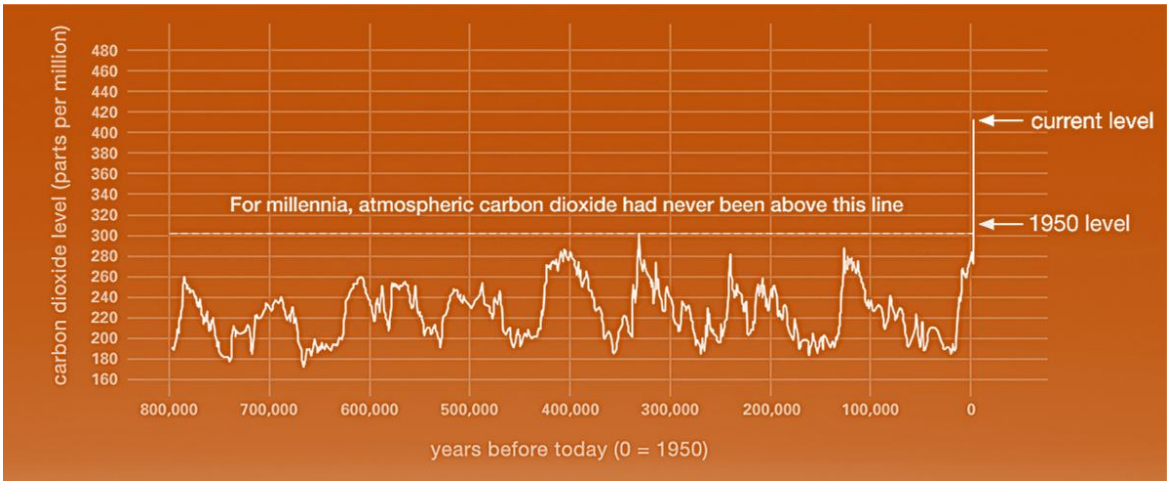
Climate change and the rise of Carbon Dioxide

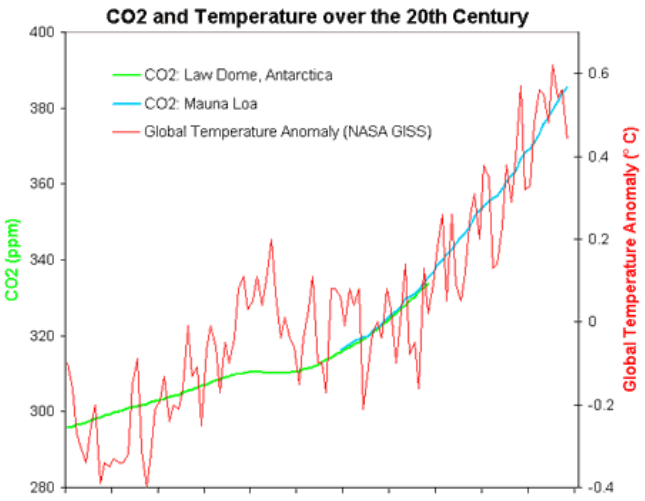
Carbon dioxide (CO_2) is a common gas. You encounter it every day. It's what you breathe out when you exhale, and it's what plants take in and use for photosynthesis. It's also released into the atmosphere in large amounts when we burn fossil fuels, like coal, gasoline, and natural gas. Carbon dioxide is what we call a "greenhouse gas", meaning it absorbs heat energy in the atmosphere and radiates it back towards the Earth, heating the land and oceans. Carbon dioxide levels in the atmosphere are climbing higher and higher, and this has big implications for the future of our planet.



This graph shows the level of carbon dioxide (CO_2) in the atmosphere for the last 800,000 years. Levels of CO_2 from the distant past were determined by analysing air bubbles from ice cores taken from ice sheets and glaciers. Although levels change over time, CO_2 stayed within a constant boundary for the vast majority of those 800,000 years. It's only after 1950 that levels skyrocket. Image from https://climate.nasa.gov/climate_resources/24/graphic-the-relentless-rise-of-carbon-dioxide/

How do we know CO_2 is causing warming?

There are multiple lines of evidence that illustrate the properties of CO_2 as a greenhouse gas and its role in Earth's greenhouse effect (to learn about these look at the suggestions for further reading). We can also look at the relationship between rising atmospheric CO_2 and rising global temperature over the last century (the graph on the right). Temperature (the red line) and CO_2 (the green and blue lines) follow the same trend.



This graph shows how temperature (the red line) and CO_2 in the atmosphere (the blue and green lines) have changed over time. Both follow the same trend. Image from https://skepticalscience.com/the-co2-temperature-correlation-over-the-20th-century.html

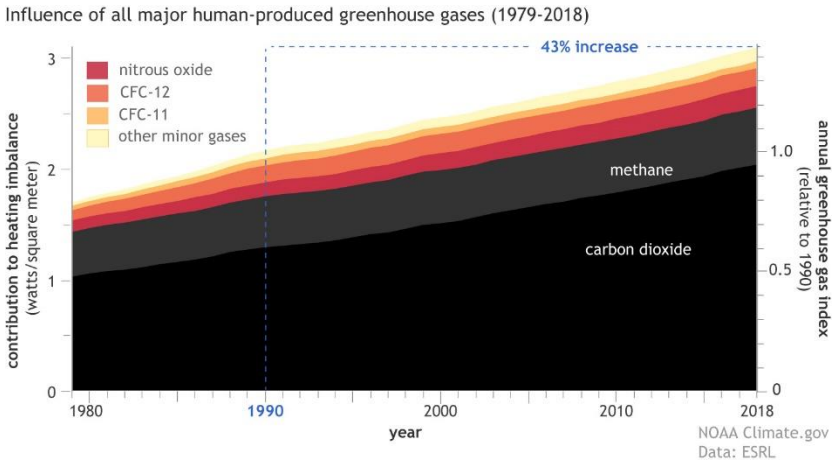
What about ice ages?

Historical shifts into and out of ice ages have been triggered by changes in the Earth's orbit (a combination of orbital eccentricity and axis tilt and wobble). But CO_2 still played a part in historic warming. Once changes in orbital cycles trigger warming, a positive CO_2 feedback loop occurs: warming oceans release CO_2 into the atmosphere, which leads to more warming, which leads to more CO_2 release, and so on. This CO_2 feedback cycle is necessary for the switch between glacial ice ages and interglacial phases.

What about other greenhouse gases?

It's true that carbon dioxide is not the only greenhouse gas in the atmosphere, but it is arguably the most important to global warming. The graph on the right shows the amount each of the major human-produced greenhouse gases contributes to global warming, and the impact of CO_2 is hard to miss.

Carbon dioxide stays in the atmosphere longer than other greenhouse gases, and it's much more abundant. It also absorbs types of heat energy that other natural greenhouse gases do not.

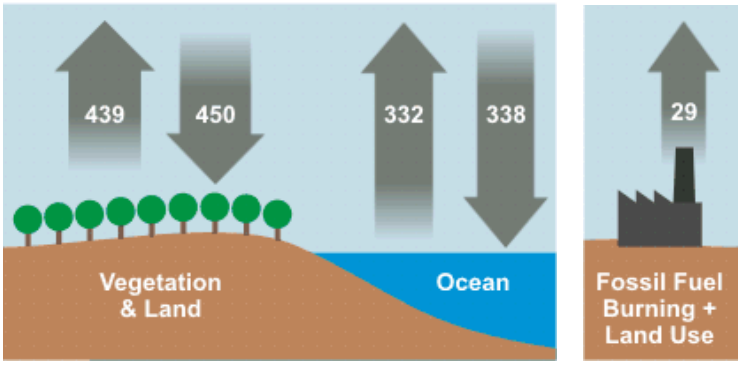


There is more than one greenhouse gas contributing to global warming, but carbon dioxide is by far the biggest influence on the heating imbalance. The combined heating influence of all major greenhouse gases has increased by 43% since 1990

Image from https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide

But CO_2 is natural, how do human CO_2 contributions make any difference?

Before humans began burning coal and other fossil fuels at ever increasing rates, the carbon dioxide in the atmosphere was all part of a natural cycle. Some processes, like photosynthesis, absorb CO_2 and others, like respiration, emit it. Without the addition of human contributions, the rate of CO_2 absorbed and emitted by the land and oceans is roughly balanced, as illustrated by the figure to the right. But humans are currently adding another 29 billion tons of CO_2 per year into the atmosphere. This is more carbon than the natural cycle can absorb, and what can't be absorbed accumulates in the atmosphere. It is this extra carbon that has led to the spike in CO_2 levels in the atmosphere that we are seeing today.



The natural global carbon cycle, without extra human emissions, is fairly balanced, with amounts being emitted almost equal to amounts being absorbed.

Images from https://skepticalscience.com/human-co2-smaller-than-natural-emissions-basic.htm

Humans emit an extra 29 billion tons of CO_2 into the atmosphere a year, pushing CO_2 levels past what the natural cycle can handle.

Carbon dioxide from human impact is pushing global temperatures higher, and we're already starting to feel the effects. The level of CO_2 in the atmosphere is beyond anything seen in the last 800,000 years. If we hope to limit the extent of climate change, cutting our CO_2 emissions needs to be part of our plan.

Want to know more? Suggestions for further reading:

https://skepticalscience.com/empirical-evidence-for-co2-enhanced-greenhouse-effect-basic.htm
https://www.researchgate.net/publication/232750246_Anthropogenic_and_natural_warming_inferred_from_changes_in_Earth's_energy_balance

UP NORTH ON CLIMATE
Climate Change Impact and Adaptation Study for the North of Ontario