



It's getting warm in our greenhouse

As we move into spring and summer, our greenhouses in our gardens are warming up nicely so we can grow tomatoes, peppers and other exotic fruits. A greenhouse traps the heat radiation from the sun, which can't easily escape so it gets hotter inside. Heat, or infra-red radiation, is part of the spectrum of light but we can only feel it, not see it. Like waves on the sea, infra-red comes in waves that can be close together (high frequency) or further apart (lower frequency). The wavelength of infra-red from the sun is relatively short and passes through greenhouse glass easily. It hits things inside and that changes its wavelength from short to a bit longer. The longer wavelength infra-red doesn't pass through glass so easily, so the greenhouse heats up.

We are experiencing something similar on a global scale but it's not glass that's trapping the heat but carbon dioxide (CO₂), methane (CH₄), water vapour (H₂O) and some other gasses. The more of these greenhouse gasses that are present in the atmosphere, the more heat is trapped at the Earth's surface (Figure 1). Instead of being reflected back by glass as in our garden greenhouse, the radiation makes the molecules of these gasses vibrate more – more vibration equals more heat. These vibrations are transferred to nitrogen and oxygen (which are not directly affected by infra-red) in the atmosphere so causing everything to warm up. This is global warming and it's causing climate change.

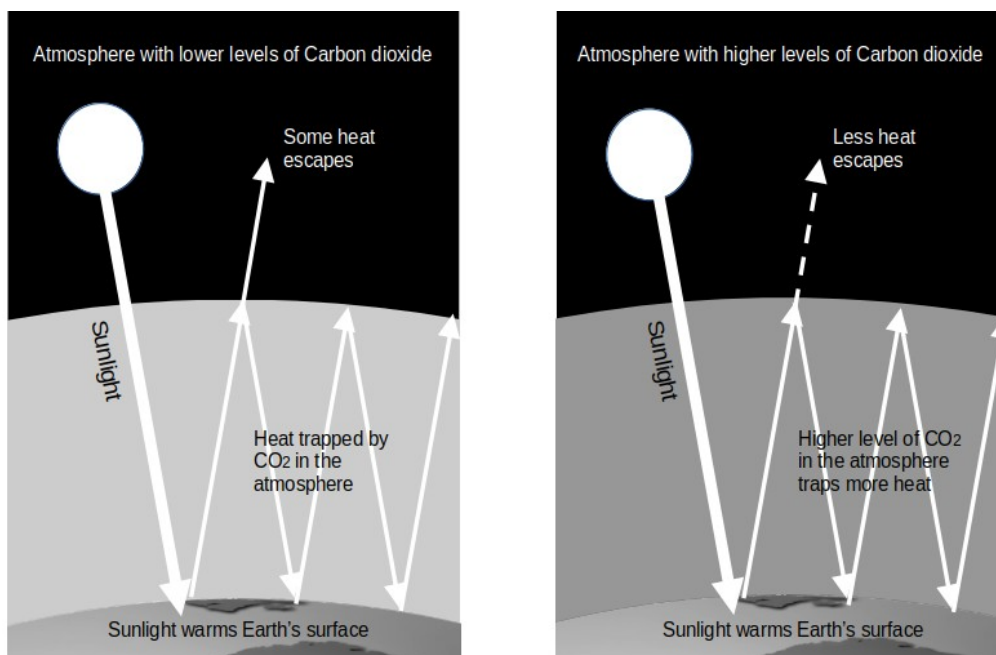


Figure 1. How increasing CO₂ causes global warming (From www.exploratorium.edu)

Greenhouse gasses have been present in our atmosphere for millions of years, though the amounts have changed at various times. We've only got direct measurement of global temperatures for about the last 175 years but research into tree ring patterns, the study of ice cores from the poles and glaciers has given us temperature and CO₂ data that goes back thousands of years. These data show that the Earth has gone through repeated warm and cold phases closely matched by levels of CO₂. Some of these changes have been caused by changes in solar radiation, tilt of the Earth's axis and the shape of our

orbit around the sun. Volcanic activity has also played a part. The global climate was fairly variable until about 200,000 years ago and gradually became less so in the succeeding millennia. Modern humans appeared about the same time. Human society started farming about 12,000 years ago, likely taking advantage of the more stable climate as the last ice age receded. Once the food supply became more secure, civilisation developed rapidly and technology moved from wooden and bone tools to stone, then bronze, iron and eventually steel.

With the industrial revolution of the 19th century, when we started burning lots of coal and then into the 20th century with oil, the amount of CO₂ going into the atmosphere increased dramatically. The actual levels are not huge but it's the increase that is important. For thousands of years, the amount of CO₂ in the atmosphere has been less than 300 parts per million (ppm) (Figure 2). But since the early part of the 20th century amounts have been increasing rapidly to a level much higher than it has been for thousands and thousands of years. Both the amount and the rate of increase are unique. In March 2025, the level has reached 428 ppm.

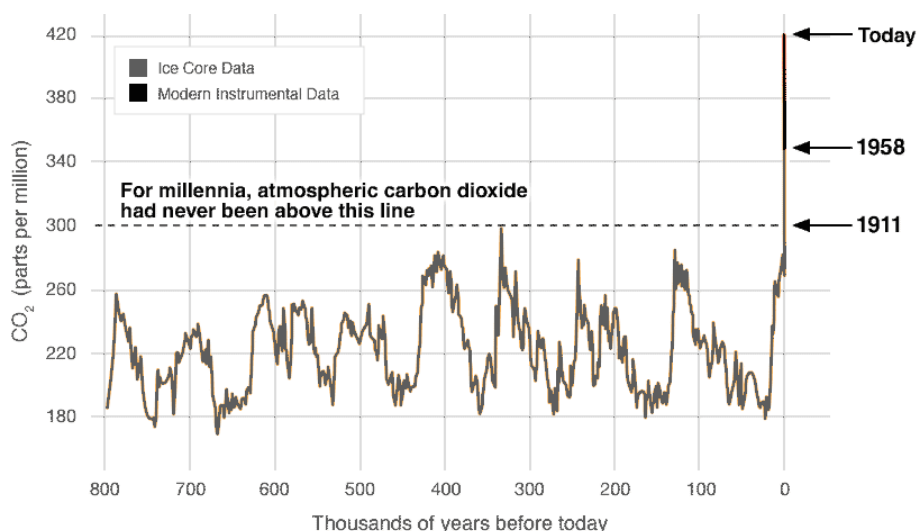


Figure 2. Atmospheric carbon dioxide (NASA)

Unfortunately, the nations of the world haven't been acting fast enough to slow or reverse the temperature rise. 2024 shattered the record of 2023 with global temperatures of 1.47 °C above the average of 1850 – 1900. Without drastic action, we are likely to see that record broken again very soon. This means hotter summers, more rain, failed crops, loss of vulnerable species and the general degradation of our environment. We do have the knowledge and technology to combat it. It presents us with a challenge but we will discover new technologies, create more jobs and end up with a better world in which to live.

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