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What is the ideal level of carbon dioxide in the atmosphere for human life?

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Atmospheric CO_2 levels of between 280 and 350 parts per million created the

by Andrew Moseman, MIT Climate Portal Writing Team

featuring guest expert Noelle Selin of MIT's Department of

climate that let humanity build and feed the modern world. The farther we get from those levels, the more we run the risk of disturbing that balance.

May 18, 2021

According to NASA, the amount of carbon dioxide (CO_2) in Earth's atmosphere was about 416 parts per million (ppm) in April 2021.[1] This level has been rising for 200 years—a worrying sign for the planet, since CO_2 is a powerful heat-trapping greenhouse gas. Climate experts warn that humanity must drastically lower its CO_2 emissions to avoid the most catastrophic consequences of climate change. But if we could choose a different level of CO_2 in the air, what number would we pick?

The first thing to know is that our species arose in a world with much less CO_2, says Noelle Selin, Associate Professor in the MIT Institute for Data, Systems and Society and the Department of Earth, Atmospheric and Planetary Sciences. As humanity evolved over the past several hundred thousand years, atmospheric CO_2 cycled between about 200 and 300 ppm. The preindustrial level of CO_2—the amount in the air a few centuries ago, before humans began to burn CO_2-producing fuels like coal and oil at an industrial scale—was about 280 ppm. Selin says a good argument could

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be made that 280 is the ideal level of CO_2 for human life, since it creates temperature ranges that are comfortable for the human body and allowed civilization to grow. "The changes that we've seen since then just haven't happened on the timescale that you could evolve changes in humans."

Another good argument could be made for trying to stabilize CO_2 parts per million in the low 300s, Selin says. Consider our cities and infrastructure: Much of the built world we live in arose during the "great acceleration," a period beginning around 1950 when economic development sped up dramatically around the world. At this time, CO_2 levels were just rising above 300 ppm, and the first effects of climate change could barely be seen. Societies built things like city flood defenses based on 20th-century assumptions about how high and how common floods would be. As a result, those defenses may be ill-equipped for today's world, when higher CO_2 levels lead to rising seas, stronger storms, and bigger floods.

The same could be said for our food system, which assumes that farmlands will get about 20th-century levels of rain and heat. Knowing this, Selin says, one could make the case that 20th-century levels of CO_2 are ideal, and that humanity ought to aim for the atmospheric levels of a few decades ago, somewhere between 300 and 350 ppm.

Unfortunately, Selin says, we cannot simply go "backward" like this. While the planet has natural carbon "sinks"

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like oceans, forests, and soils that remove some CO_2 from the atmosphere, that process is very slow. Researchers like MIT's John Sterman have called this the "bathtub effect." Think of a tub full of water with a painfully slow drain: Even if you turned off the faucet, it would take a long time for the water already in the tub to drain out. In the case of the atmosphere, this means that even if humanity immediately halted CO_2 emissions, the extra carbon we've already put in the atmosphere would continue to change our climate as it slowly drains out—and that "drain" might take centuries or millennia to finish its work. Meanwhile, technology that removes CO_2 from the air exists now in prototype form, but is a long way from the level of sophistication that could bring down the atmospheric level of CO_2. "Climate change is essentially irreversible on human timescales," Selin says.

What is clearly not ideal is the constantly rising level of CO_2 we have today, which pushes the climate further away from the best conditions for us, our cities, and our societies. In 2016, a worldwide body of climate scientists[2] said that a CO_2 level of 430 ppm would push the world past its target for avoiding dangerous climate change. The sooner humankind dramatically cuts its CO_2 emissions, the less we will have to adapt to a warmer climate.

Thank you to George Reeves of Raleigh, North Carolina, for the question. You can submit your own question to Ask MIT Climate here.

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FOOTNOTES

[1] NASA Global Climate Change: Vital Signs of the Planet: Carbon Dioxide ⌐. Accessed May 18, 2021.

[2] An Intergovernmental Panel on Climate Change report summarized the impacts of global warming of about 1.5 degrees Celsius ⌐ over pre-industrial levels, a goal that would avoid the most catastrophic results for civilization. Holding CO_2 at no more than 430 ppm should allow the world to avoid overshooting the 1.5-degree goal. At current rates, though, that level of atmospheric carbon is just a few years away.
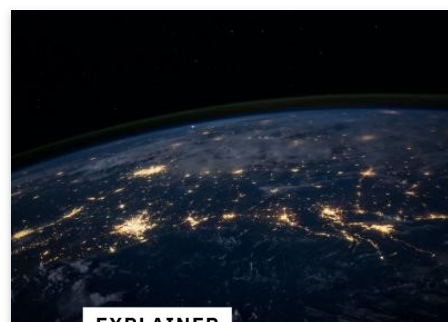
Want to learn more?

Listen to this episode of MIT's "Today I Learned: Climate" podcast featuring Noelle Selin.

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Is it too late?

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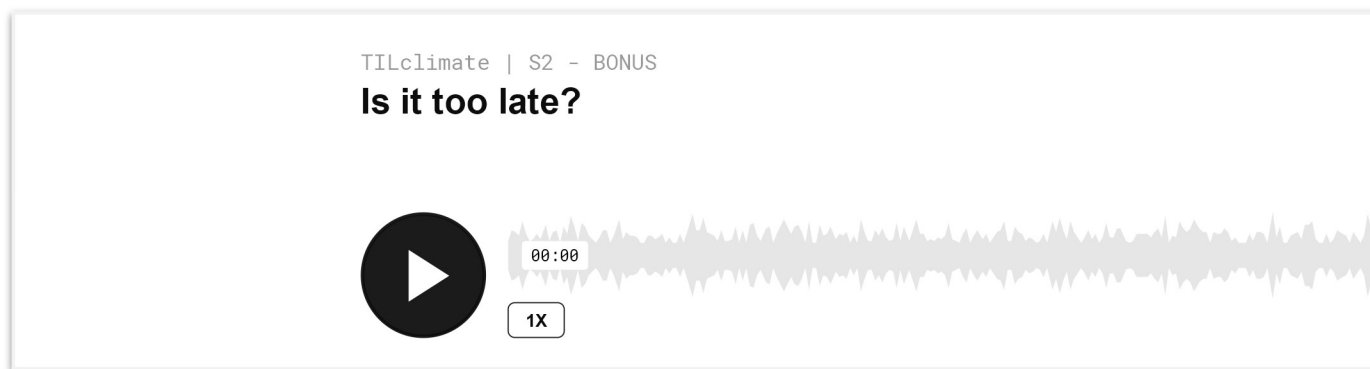
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