

Scientists reveal how landmark CFC ban gave planet fighting chance against global warming

August 18 2021



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Without the global CFC ban we would already be facing the reality of a 'scorched earth', according to researchers measuring the impact of the Montreal Protocol.

Their new evidence reveals the planet's critical ability to absorb carbon from the atmosphere could have been massively degraded sending global

temperatures soaring if we still used [ozone](#)-destroying chemicals such as CFCs.

New modeling by the international team of scientists from the UK, U.S. and New Zealand, published today in *Nature*, paints a dramatic vision of a scorched planet Earth without the Montreal Protocol, what they call the "World Avoided". This study draws a new stark link between two major environmental concerns—the hole in the [ozone layer](#) and [global warming](#).

The research team, led by a Lancaster University scientist, reveals that if ozone-destroying chemicals, which most notoriously include CFCs, had been left unchecked then their continued and increased use would have contributed to global air temperatures rising by an additional 2.5°C by the end of this century.

Their findings, outlined in the paper 'The Montreal Protocol protects the terrestrial carbon sink', show that banning CFCs has protected the climate in two ways—curbing their [greenhouse effect](#) and, by protecting the ozone layer, shielding plants from damaging increases in ultraviolet radiation (UV). Critically, this has protected plant's ability to soak up and lock in carbon dioxide from the atmosphere and so prevented a further acceleration of climate change.

The research team developed a new modeling framework, bringing together data on ozone depletion, plant damage by increased UV, the carbon cycle and climate change. Their novel modeling shows an alternative future of a planet where the use of CFCs continued to grow by around three percent a year.

Their modeling reveals:

- Continued growth in CFCs would have led to a worldwide

collapse in the ozone layer by the 2040s.

- By 2100 there would have been 60 percent less ozone above the tropics. This depletion above the tropics would have been worse than was ever observed in the hole that formed above the Antarctic.
- By 2050 the strength of the UV from the sun in the mid-latitudes, which includes most of Europe including the UK, the United States and central Asia, would be stronger than the present day tropics.

The depleted ozone layer would have seen the planet, and its vegetation, exposed to far more of the sun's UV.

Plants absorb [carbon dioxide](#) (CO₂) through photosynthesis and studies have shown that large increases in UV can restrict plant growth, damaging their tissues, and impairing their ability to undertake photosynthesis. This means the plants absorb less carbon.

Less carbon in vegetation also results in less carbon becoming locked into soils, which is what happens to a lot of plant matter after it dies. All of this would have happened on a global scale.

The researchers' models show that in a world without the Montreal Protocol the amount of carbon absorbed by plants, trees and soils dramatically plummets over this century. With less carbon in plants and soils, more of it remains in the atmosphere as CO₂.

Overall, by the end of this century without the Montreal Protocol CFC ban:

- There would have been 580 billion tons less carbon stored in forests, other vegetation and soils.
- There would be an additional 165-215 parts per million of CO₂

in the atmosphere, depending on the future scenario of fossil fuel emissions. Compared to today's 420 parts per million CO₂, this is an additional 40-50%.

- The huge amount of additional CO₂ would have contributed to an additional 0.8°C of warming through its greenhouse effect.

Ozone depleting substances, such as CFCs, are also potent greenhouse gases and previous research has shown that their ban prevented their contribution to global warming through their greenhouse effect. By the end of this century, their greenhouse effect alone would have contributed an additional 1.7°C global warming. This is in addition to the newly quantified 0.8°C warming, coming from the extra CO₂ that would have resulted from damaged vegetation, meaning that temperatures would have risen 2.5°C overall.

Dr. Paul Young, lead author from Lancaster University, said: "Our new modeling tools have allowed us to investigate the scorched Earth that could have resulted without the Montreal Protocol's ban on ozone depleting substances.

"A world where these chemicals increased and continued to strip away at our protective ozone layer would have been catastrophic for human health, but also for vegetation. The increased UV would have massively stunted the ability of plants to soak up carbon from the atmosphere, meaning higher CO₂ levels and more global warming.

"With our research, we can see that the Montreal Protocol's successes extend beyond protecting humanity from increased UV to protecting the ability of plants and trees to absorb CO₂. Although we can hope that we never would have reached the catastrophic world as we simulated, it does remind us of the importance of continuing to protect the ozone layer. Entirely conceivable threats to it still exist, such as from unregulated use of CFCs."

The planet has already seen 1°C warming from pre-industrial temperatures. Even if we had somehow managed to get to net zero CO₂ emissions, the additional 2.5°C rise would take us to a rise of 3.5°C. This is far in excess of the 1.5°C rise above pre-industrial levels that many scientists see as the most [global temperatures](#) can rise in order to avoid some of the most damaging effects of climate change.

Dr. Chris Huntingford of the UK Centre for Ecology & Hydrology said: "This analysis reveals a remarkable linkage, via the [carbon](#) cycle, between the two global environmental concerns of damage to the ozone layer and global warming."

More information: The Montreal Protocol protects the terrestrial carbon sink, *Nature* (2021). [DOI: 10.1038/s41586-021-03737-3](https://doi.org/10.1038/s41586-021-03737-3) , www.nature.com/articles/s41586-021-03737-3

Provided by Lancaster University

Citation: Scientists reveal how landmark CFC ban gave planet fighting chance against global warming (2021, August 18) retrieved 9 April 2024 from <https://phys.org/news/2021-08-scientists-reveal-landmark-cfc-gave.html>

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