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Long-term data on atmospheric carbon dioxide reveals an intensification of carbon uptake by Northern Hemisphere vegetation

Northern Hemisphere vegetation has kept pace in absorbing increasing amounts of carbon dioxide in the atmosphere due to human activities over the last 60 years, partially offsetting the effects of global warming. Scientists analyzed data since 1958 that showed the Northern Hemisphere land sink, mainly forests, had intensified its absorption as plants thrived due to more CO2 in the atmosphere.

Accelerated increases in fossil fuel emissions during the 2000s, due to increased economic output from countries in east and south Asia, caused a group international scientists to examine if land and ocean sinks would be able to keep up with this increase in atmospheric CO2.

On average, global lands and oceans have been known to absorb as much as 50 percent of the CO2 emitted from human activities. These are known as carbon sinks. The portion left over in the atmosphere is known as the airborne fraction. As more and more CO2 has entered the atmosphere, the scientists suspected the airborne fraction could have increased over this time, as plants, soils, and oceans may not have been able absorb the same percentage of CO2 as in the past.

What they found was that global land and ocean sinks have largely kept pace with increasing carbon dioxide emissions since 1958, as 60 years later they are still absorbing about 50 percent of atmospheric CO2. This intensification of absorption can be traced to the Northern Hemisphere land sink responding to continued emissions growth, mainly through forests.

Pep Canadell, co-author of the new paper and Executive Director of the Global Carbon Project at CSIRO, Australia, finds these results so remarkable because of their unseen, and often unacknowledged, benefits:

"The CO2 sinks are like a 50 percent discount on climate change. If it wasn't for the sinks, we would have double the accumulation of CO2 in the atmosphere, and a doubling of the impacts due to global warming."

Together the researchers, led by Philippe Ciais from the Laboratory for Climate and Environmental Sciences (CEA / CNRS / UVSQ) in Paris, examined the interhemispheric gradient and CO2 emissions between 1958 to 2016. The interhemispheric gradient of atmospheric CO2 is defined as the observed difference between the two oldest recording stations: Mauna Loa station in Hawaii and one at the South Pole, which record CO2 growth rates representative of the averages of their respective Northern and Southern hemispheres.

The Northern Hemisphere is home to approximately two-thirds of the land and vegetation on Earth, while the Southern Hemisphere is dominated by the ocean sink. The Northern Hemisphere is also where most developed countries producing carbon emissions are located. Therefore, the Northern Hemisphere always has a higher concentration of CO2 than the southern half of the planet. However, the gradient between the two from 1958 to 2016 was smaller than expected, leading them to conclude that a key reason was due to an intensification of the Northern Hemisphere land sink over the past decade.

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While the Northern Hemisphere land sink will continue to grow, it may soon do so at a lower and declining efficiency. Some regional research in the Amazon and in permafrost regions are already indicating early signs.

As CO2 increases, plants thrive and the overall absolute sinks will also increase. But due to warming temperatures and other variables, they will lose efficiency. And in some instances, models have shown that by 2100 some land sinks could reverse – or start emitting the carbon they have stored back into the atmosphere.

According to the last decade of research by the Global Carbon Project in its annual global carbon budget, on average, the land sinks of the world have absorbed 29 percent of global CO2 from human activities, followed by the oceans at 22 percent.

The ocean sink has largely kept pace with increasing carbon emissions, but warmer oceans will become less efficient in removing atmospheric CO2. However, the benefits of the ocean sink have a catch: ocean acidification, which is detrimental and even deadly for a wide variety of marine life and chemical processes.

Land sinks do not necessarily have negative effects, but are seen as beneficial. However, with increased agricultural production, carbon is not necessarily stored long-term – but returns to the atmosphere quite quickly. And more photosynthesis means more vegetation growth, which in some parts of the world can reduce water availability and higher fire risk.

This research also carries heavy implications for reaching temperature goals on climate change, such as the Paris agreement. A small change in the strength of the sink on land or in the ocean could be equivalent to hundreds of millions of dollars annually, if the loss of a sink were needed to be replaced by human-made sinks or with further emission reductions through carbon markets. Or to meet the same targets, it could simply become more difficult or unachievable.

Better management of all lands, and particularly forested lands, including the reduction of deforestation, are emphasized as essential actions to preserve this natural benefit and reach climate mitigation goals.

"We need to be aware of how incredibly beneficial this free ecosystem service we get from the land sinks is and, to the extent we can, we need to make sure we protect them. And if there's anything from a management point of view that can be done, we should certainly plan for it," said Philippe Ciais, lead author of the study.

Paper:

Ciais, P., et al. (2019). Five decades of northern land carbon uptake revealed by the interhemispheric CO2 gradient. *Nature*. http://doi.org/10.1038/s41586-019-1078-6

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