Long-term data on atmospheric carbon dioxide reveals an increase in carbon uptake by Northern Hemisphere vegetation

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Based on long-term data on atmospheric carbon dioxide concentrations, an international group of scientists coordinated by the Laboratory of Climate and Environmental Sciences (CEA/CNRS/UVSQ) have discovered that vegetation in the Northern Hemisphere is absorbing

increasing amounts of the CO_2 produced by human activities, thereby partially offsetting the effects of global warming. The research was published in *Nature* on 3 April 2019.

Origin of the discovery

In the early 1990s, a small number of atmospheric observatories and ocean data led to the discovery that terrestrial biomes in the Northern Hemisphere absorb substantial amounts of CO_2. This discovery, initially disputed, was later confirmed by forest biomass inventories and the establishment of new atmospheric measurement stations.

Thirty years later, the exact magnitude and trend of the terrestrial carbon sink in the Northern Hemisphere remain uncertain. The results of carbon cycle models differ from one another. The rich diversity of ecosystems, ranging from Mediterranean shrubs to Arctic tundra, the widely varying methods of managing these environments, particularly forest harvesting and farming practices, and events such as droughts and fires make it very difficult to estimate carbon budgets on a continental scale.

An international team of researchers, coordinated by the Laboratory of Climate and Environmental Sciences (CEA/CNRS/UVSQ), reconstructed the evolution of continental carbon sinks using atmospheric CO_2 content records between 1958 and 2016. These unique records, which cover a period of over 50 years, come from the two oldest atmospheric CO_2 measurement stations: Mauna Loa in Hawaii for the Northern Hemisphere and the South Pole in Antarctica for the Southern Hemisphere.

Northern Hemisphere vegetation: essential to slowing global warming

The difference between CO_2 records in the Northern and Southern Hemispheres shows that the concentration of carbon dioxide in the atmosphere remains higher on average in the north. This is due to CO_2 emissions from fossil fuels, which are mainly produced by industrialized regions located in the Northern Hemisphere. However, this difference in concentration is not as significant as the difference between fossil-fuel emission levels in the two hemispheres suggests. This can only be explained by an intensification of the carbon sink each year, partly in the oceans but mainly in continents in the Northern Hemisphere.

Until now, it has been known that land vegetation and oceans absorb as much as half of the CO_2 emitted by human activities. This new study shows that the vegetation sink in the Northern Hemisphere has made a dominant contribution to global carbon uptake over the past 50 years. Far from being compromised by recent droughts and climate changes, this carbon sink has increased considerably over the last twenty years.

"Since 1958, Northern Hemisphere vegetation has continued to absorb a significant amount ofCO_2, with two significant increases in uptake: once in the 1990s and then again in the 2000s. On the other hand, the carbon uptake in southern continents seems to be stagnating," explains Philippe Ciais, the researcher at the Laboratory of Climate and Environmental Studies who led the analysis. "The models of the carbon cycle in vegetation and soils used to assess future CO_2 projections and consider climate change have not been able to replicate the intensification of CO_2 uptake observed in the 2000s."

Several hypotheses have been put forward to explain this real phenomenon of increased carbon uptake in the Northern Hemisphere, which does not correspond to model simulations: the growth and relatively young age of forests, particularly in North America and China, as well as the fertilization of ecosystems in Asia that have been exposed to increased amounts of nitrogen from the atmosphere and to changes in

soil management practices.

Reconstructing the CO_2 balance of Northern Hemisphere ecosystems over nearly sixty years thereby helps climatologists to better understand the carbon cycle and establish a reference base for conservation or carbon sequestration actions in soils and biomass over the coming decades.

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

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