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Warming Will Unlock Carbon in Forests, Study Warns

By FELICITY BARRINGER

Climate scientists have long been concerned about the possibility that warming temperatures will speed changes on the earth's surface that will in turn accelerate global warming. The best illustration of such a feedback loop involves the melting of sea ice in the Arctic. The ice reflects solar radiation back into space rather than absorbing it. When it melts, it leaves open water that absorbs the heat rather than reflecting it. The more warm water there is, the more ice melts, and so on.

Now scientists have identified another feedback loop that may be accelerating the loss of carbon dioxide from the topsoil of forests in the United States, contributing to climate change. In a study published online on Monday, researchers at the University of California, Irvine, and the Lawrence Berkeley National Laboratory found that as temperatures rise, activity increases among the microbes that eat the topsoil and exhale carbon dioxide afterward.

While that finding is not surprising, said the lead author, Francesca Hopkins, a doctoral researcher in the Department of Earth System Science at Irvine, she and her collaborators also found that in warmer temperatures the microbes were better able to digest decades-old carbon stored in the soils. Scientists had previously believed that the old carbon was inaccessible because it had become fixed in the soil; that belief has become a magnet for new studies and controversy.

The new study was published online in the Proceedings of the National Academy of Sciences.

"This has been really hotly debated in the past decade or so," Ms. Hopkins said in an interview. "Some people think the older soil carbon would decompose more quickly" as temperatures increase, "and some think it wouldn't decompose at all, because it had stabilized." The mechanisms by which carbon is stabilized in the soil are poorly understood, although it is clear that some carbon molecules bind to mineral particles in the soil, she said.

But after collecting soils from woodlands in North Carolina and Wisconsin and putting them in Mason jars, then storing the jars in incubators at different temperatures, "we saw that the microbes could access some carbon that is at least a decade old," she said.

The age of the carbon was determined by the isotopes in the carbon dioxide exhaled by the microbes; carbon older than a decade has a distinctive isotope signature. The scientists were able to pinpoint the age of the carbon that had been stored for less than a decade more precisely by measuring a different set of isotopes.

The study reported an eightfold increase in carbon dioxide production when temperatures were increased by 20 degrees Celsius (36 degrees Fahrenheit). This is far in excess of the range of temperature increases predicted to occur by the end of the century under existing climate models. Under the moderate warming predicted by the Intergovernmental Panel on Climate Change, Ms. Hopkins's experiment indicated that the respiration rates of the microbes -- and the amount of carbon dioxide they exhale -- would roughly double by 2100.

The ability to measure the age of the carbon in the soil could be an increasingly useful tool for scientists, although the measurements are still being refined. The components of soil, including decaying leaves, roots and other vegetable matter, store at least twice as much carbon as the chemicals in the atmosphere, according to United Nations climate reports.

The findings of the new study further complicate the dynamics underlying the role of forests in carbon storage. Forests are widely known as repositories of carbon -- about 104 billion tons of it worldwide -- but the role they will play in a warming world is less understood, although crucial, as my colleague Justin Gillis reported in an extensive article last fall. If they become carbon emitters rather than carbon sinks as temperatures rise, projections of how fast climate change will occur may have to be adjusted.