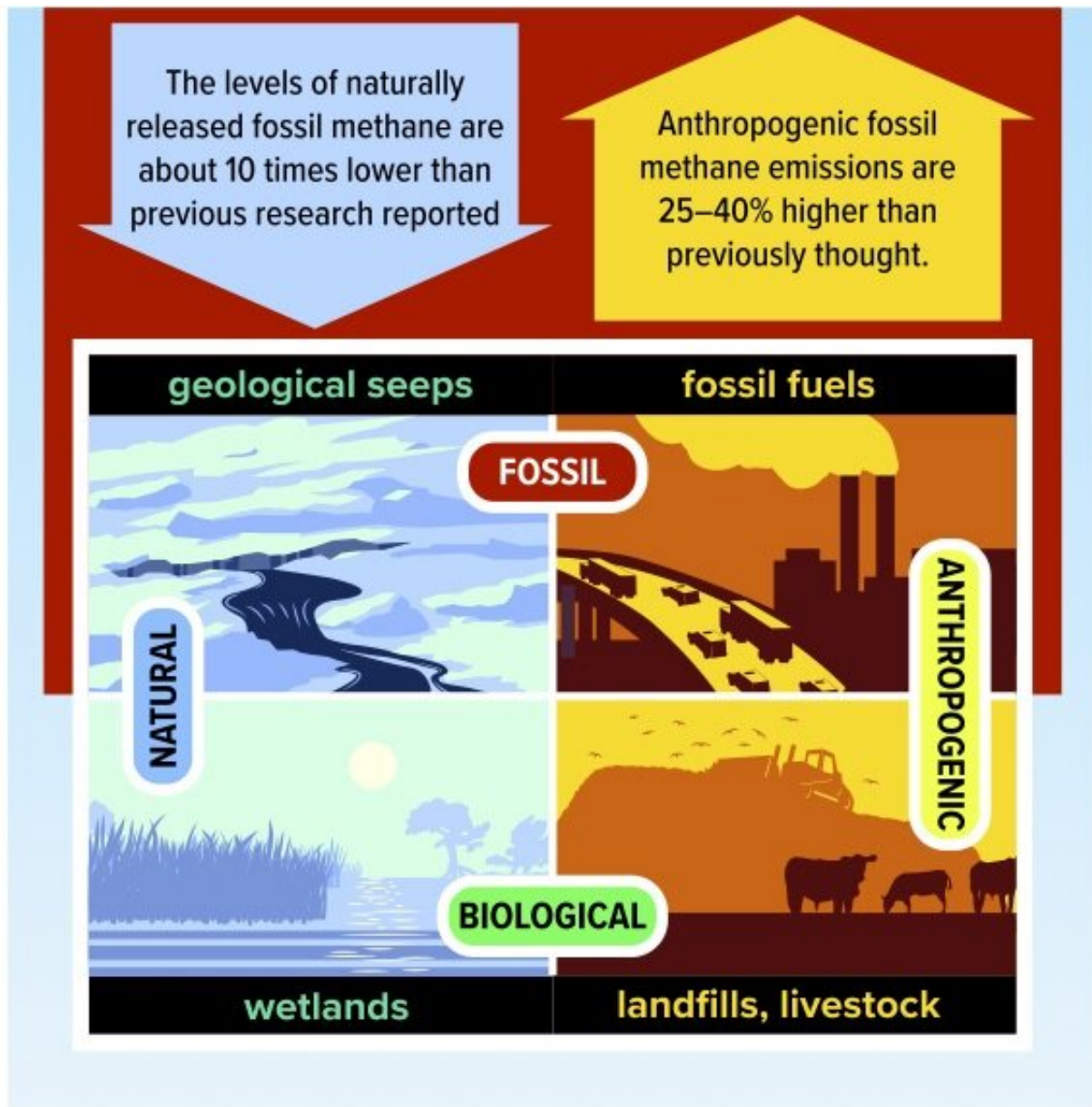


Methane emitted by humans vastly underestimated, researchers find

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Methane emitted into the atmosphere can be sorted into two categories, based on its signature of carbon-14, a rare radioactive isotope. Fossil methane has been sequestered for millions of years in ancient hydrocarbon deposits and no longer contains carbon-14; biological methane is in contact with plants and wildlife on the planet's surface and does contain carbon-14. Biological methane can be released naturally from sources such as wetlands or via anthropogenic sources such as landfills, rice fields, and livestock. Fossil methane can be emitted via natural geologic seeps or as a result of humans extracting and using fossil fuels. Credit: University of Rochester illustration / Michael Osadciw

Methane is a powerful greenhouse gas and large contributor to global warming. Methane emissions to the atmosphere have increased by approximately 150 percent over the past three centuries, but it has been difficult for researchers to determine exactly where these emissions originate; heat-trapping gases like methane can be emitted naturally, as well as from human activity.

University of Rochester researchers Benjamin Hmiel, a postdoctoral associate in the lab of Vasilii Petrenko, a professor of earth and environmental sciences, and their collaborators, measured methane levels in ancient air samples and found that scientists have been vastly underestimating the amount of methane humans are emitting into the atmosphere via [fossil fuels](#). In a paper published in *Nature*, the researchers indicate that reducing [fossil fuel use](#) is a key target in curbing climate change.

"Placing stricter methane emission regulations on the [fossil fuel industry](#) will have the potential to reduce future [global warming](#) to a larger extent than previously thought," Hmiel says.

Two types of methane

Methane is the second largest anthropogenic—originating from [human activity](#)—contributor to global warming, after carbon dioxide. But, compared to carbon dioxide, as well as other heat-trapping gases, methane has a relatively short shelf-life; it lasts an average of only nine years in the atmosphere, while carbon dioxide, for instance, can persist in the atmosphere for about a century. That makes methane an especially suitable target for curbing emission levels in a short time frame.

"If we stopped emitting all carbon dioxide today, high [carbon dioxide](#) levels in the atmosphere would still persist for a long time," Hmiel says. "Methane is important to study because if we make changes to our current [methane emissions](#), it's going to reflect more quickly."

Methane emitted into the atmosphere can be sorted into two categories, based on its signature of carbon-14, a rare radioactive isotope. There is fossil methane, which has been sequestered for millions of years in ancient hydrocarbon deposits and no longer contains carbon-14 because the isotope has decayed; and there is biological methane, which is in contact with plants and wildlife on the planet's surface and does contain carbon-14. Biological methane can be released naturally from sources such as wetlands or via anthropogenic sources such as landfills, rice fields, and livestock. Fossil methane, which is the focus of Hmiel's study, can be emitted via natural geologic seeps or as a result of humans extracting and using fossil fuels including oil, gas, and coal.

Scientists are able to accurately quantify the total amount of methane emitted to the atmosphere each year, but it is difficult to break down this total into its individual components: Which portions originate from fossil sources and which are biological? How much methane is released naturally and how much is released by human activity?

"As a scientific community we've been struggling to understand exactly how much methane we as humans are emitting into the atmosphere,"

says Petrenko, a coauthor of the study. "We know that the fossil fuel component is one of our biggest component emissions, but it has been challenging to pin that down because in today's atmosphere, the natural and anthropogenic components of the fossil emissions look the same, isotopically."

Turning to the past

In order to more accurately separate the natural and anthropogenic components, Hmiel and his colleagues turned to the past, by drilling and collecting ice cores from Greenland. The ice core samples act like time capsules: they contain air bubbles with small quantities of ancient air trapped inside. The researchers use a melting chamber to extract the ancient air from the bubbles and then study its chemical composition.

Hmiel's research focused on measuring the composition of air from the early 18th century—before the start of the Industrial Revolution—to the present day. Humans did not begin using fossil fuels in significant amounts until the mid-19th century. Measuring emission levels before this time period allows researchers to identify the natural emissions absent the emissions from fossil fuels that are present in today's atmosphere. There is no evidence to suggest natural fossil methane emissions can vary over the course of a few centuries.

By measuring the carbon-14 isotopes in air from more than 200 years ago, the researchers found that almost all of the methane emitted to the atmosphere was biological in nature until about 1870. That's when the fossil component began to rise rapidly. The timing coincides with a sharp increase in the use of fossil fuels.

The levels of naturally released fossil methane are about 10 times lower than previous research reported. Given the total fossil emissions measured in the [atmosphere](#) today, Hmiel and his colleagues deduce that

the manmade fossil component is higher than expected—25-40 percent higher, they found.

Climate change implications

The data has important implications for climate research: if anthropogenic methane emissions make up a larger part of the total, reducing emissions from human activities like fossil [fuel](#) extraction and use will have a greater impact on curbing future global warming than scientists previously thought.

To Hmiel, that's actually good news. "I don't want to get too hopeless on this because my data does have a positive implication: most of the [methane](#) emissions are anthropogenic, so we have more control. If we can reduce our emissions, it's going to have more of an impact."

More information: Preindustrial 14CH_4 indicates greater anthropogenic fossil CH_4 emissions, *Nature* (2020). [DOI: 10.1038/s41586-020-1991-8](#) , [nature.com/articles/s41586-020-1991-8](https://www.nature.com/articles/s41586-020-1991-8)

Provided by University of Rochester

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