The rise, fall, then rise again of a powerful global warming gas

Lauren Morello, Environment & Energy Publishing, 8-11-11

Call it "The Case of the Missing Methane."

Scientists were stumped when the concentration of the powerful greenhouse gas leveled off at the end of the 20th century, after increasing for nearly a century. Now a pair of studies published yesterday in *Nature* presents two different, seemingly conflicting, theories about what happened.

One study argues that changing agricultural practices, especially among Asia's rice farmers, caused the methane slowdown between 1980 and 2000. The other makes the case that changes in fossil fuel production and use -- including greater demand for natural gas -- are the culprit.

But there's one idea that both sets of scientists agree on: Figuring out why atmospheric methane leveled off in the late 20th century will help researchers explain why methane emissions are creeping up again, and whether that trend will continue.

The stakes are high. Methane -- emitted by a wide array of sources, including fossil fuel production, livestock, burning forests and plants, rice farming and landfills -- is the second-largest contributor to climate change after carbon dioxide.

"There was a massive increase in the methane concentration in the atmosphere during most of the 20th century, then within three decades it basically became flat," said Jim Randerson, a University of California, Irvine, scientist who studies the global carbon cycle. "What caused the slowdown and leveling off of methane has been a mystery in carbon-cycle science."

Randerson and three colleagues at UCI attempted to solve that mystery by examining the chemical composition of methane in air samples collected from the late 1980s to 2005.

Their method relied on the fact that methane emissions from fossil fuel production carry a different chemical signature from methane emissions produced by agricultural sources.

Comparing chemical signatures

Each molecule of methane (chemical formula: CH4) is composed of one carbon atom and four hydrogen atoms. But each source of methane produces gas that carries a telltale ratio of two carbon isotopes: carbon with 12 neutrons (carbon-12) and carbon with 13 neutrons (carbon-13).

Examining the isotopic ratio of carbon in their methane samples led Randerson's team to the conclusion that changing farm practices in Asia, including the replacement of manure with inorganic fertilizers and more efficient water use, caused the concentration of methane in the atmosphere to level off in the late 20th century.

The scientists estimate that the agricultural shift was responsible for about half the decrease of methane emissions in the Northern Hemisphere during that time.

But a very different explanation is put forth in the second study, led by Murat Aydin -- another researcher from the University of California, Irvine, whose office sits three doors down the hall from Randerson's.

Aydin and his team examined air trapped in perennial snowpack at research stations in Greenland and Antarctica. But they weren't looking for methane. Instead, they tracked changes in the concentration of a related gas, ethane.

"Ethane is similar to methane, but a lot simpler to analyze," Aydin said, because it is produced by fewer sources than methane -- largely fossil fuel burning. The researchers were able to use their ethane data as a proxy for one slice of the world's methane budget, the methane produced by fossil fuel production and use.

"We cannot comment about what all the other sources of methane did," Aydin said. "What we can do, looking at ethane, is isolate the fossil fuel source."

His analysis suggests that emissions of methane from that one source, fossil fuel production and use, dropped enough between 1980 and 2000 to account for the change in total amount of methane in the atmosphere during that time.

"We think that probably the economic value of natural gas had a lot to do with it," Aydin said. "In the first half of the 20th century, we cared about oil and coal, but we didn't really care about natural gas. That started to change midcentury."

Some room for consensus

As the economic value of natural gas rose, Aydin speculates, industry became more likely to capture it instead of allowing it to vent into the atmosphere.

It's a very different explanation that Randerson's theory of changing agricultural practices. So who's right? Randerson and Aydin aren't sure, even though each is confident in his respective work.

"There is a really good possibility that both studies have elements that are right," Randerson said. "It's going to take some work to reconcile them in the science community. This is kind of the way science moves forward."

Aydin agreed. "There may be partial truth in both of them," he said. "There are certainly some assumptions in both studies. There could be errors there. There also definitely could be some middle ground."

What is clear, said Martin Heimann, director of Germany's Max Planck Institute for Biogeochemistry, is that more research is needed to develop a definitive answer.

"The different scenarios are plausible and compatible with their respective observations," he said in an essay also published by *Nature*. "The challenge now is to bring the different lines of evidence together. ... More insight is needed to solve the enigma of the recent methane budget if the evolution of this important greenhouse gas over the twenty-first century is to be predicted."

Heimann has invited both teams of researchers to a conference next month at the Planck Institute, where 20 scientists from around the world will draw on the latest research to come up with a more accurate accounting of methane sources and sinks.