Looking to space to quantify natural gas leaks on Earth

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A composite image of the Western hemisphere of the Earth. Credit: NASA

The recent increase in natural gas production could provide a bridge to a lower carbon future because it generates half the carbon dioxide (CO_2) of coal when burned. However, natural gas that is leaked into the atmosphere could speed global warming and climate change. That's because its primary component, methane, is a much more powerful greenhouse gas than CO_2. Understanding the leakage rate is critical to assessing the environmental benefit of natural gas, but there is much controversy, debate and confusion among scientists and policy-makers over just how much methane is lost to the atmosphere.

Researchers today will present new methods to determine methane's leakage rate and problems inherent in discovering and assessing leakage at the 249th National Meeting & Exposition of the American Chemical Society (ACS).

"I will discuss new and different techniques we are developing to make atmospheric observations that are being used to locate, quantify and attribute sources of leaked methane emissions," says Eric Kort, Ph.D. "Also, we are using for the first time space-based observations to identify and quantify methane emissions from broad energy production regions and have found unexpected, high methane releases in a part of the U.S."

Methane leakage rates are currently a hot policy issue as the Environmental Protection Agency (EPA) and several states consider regulations to cover oil and gas operations, including hydraulic fracturing or "fracking." About 30 percent of methane emissions are estimated to come from oil and gas operations, and about half of that is from drilling. Kort, who is at the University of Michigan, explains that getting a handle on leakage is complicated, considering the U.S. has more than 500,000 oil and gas wells.

Estimates by the oil and gas industry and the EPA show low leakage rates. However, the rates are being challenged, and recent studies have turned up higher emission rates. Studies, like those of Kort and his colleagues, are trying to resolve these mismatches.

In a scientific paper published last fall (Geophys. Res. Lett., 2014, DOI: 10.1002/2014GL061503), Kort and his team turned to satellite observations to identify global methane leakage hot spots. "We combine those space-based numbers with modeling to quantify emissions," Kort says.

The team used data from the European Space Agency's Scanning Imaging Absorption Spectrometer for Atmospheric Cartography to measure methane in each of seven years studied from 2003-2009. Then, the scientists calculated the emissions rate that would be required to produce the methane concentrations and performed high-resolution regional simulations. To do this, they used a chemical transport model that simulates how weather moves and changes airborne chemical compounds.

They found the emissions rate to be three times higher than expected in a swath of the southwestern U.S. But Kort stresses that identification is only the first step. Now they are further exploring the various sources of these methane emissions and expanding their measurement techniques.

Options atmospheric scientists now use to quantify and validate emissions estimates include ground-based observations from mobile measurement vans, as well as data from aircraft flying over potential methane sources, he says.

Complicating measurements, methane also comes from many non-fossil fuel sources, such as farm animals. To make that determination, Kort and his team measure both methane and ethane, which have distinct signatures. "The two are different compounds with different properties," he notes. "Methane from oil and gas contains ethane, but biogenic methane from landfills, cattle and wetlands does not. So ethane becomes a nice tracer, or indicator, of whether methane is from a fossil or non-fossil source.

"There are no silver bullets," he says, "but each technique has advantages we can employ and disadvantages that we must consider."

More information: Locating, quantifying, and attributing methane emissions from fossil-fuel extraction, 249th National Meeting & Exposition of the American Chemical Society (ACS).

Abstract

Recent technological advances have led to large and rapid increases in oil and natural gas extraction in the United States. The increasing abundance of lower cost natural gas has the potential to displace less efficient fossil sources, and has been considered a potentially important 'bridge' fuel to more sustainable energy sources. However, the climate value of natural gas requires low leakage rates prior to combustion, as atmospheric methane acts as a potent greenhouse gas. Recently, the leakage rates associated with the new boom in natural gas harvesting with high-volume hydraulic fracturing has come into question, impacting the climate-value of natural gas. To make informed societal decisions we need quantitative information on methane emissions. In this talk I will discuss different observational techniques in which atmospheric observations are used to locate, quantify, and attribute fugitive methane emissions. I will discuss the first example of identifying and quantifying anomalous methane emissions from a region of energy production using space-based observations. I will also present new airborne observations of ethane and methane over multiple oil and gas fields in Texas and North Dakota, and demonstrate how these observations can be used to both quantify ethane emissions and partition methane emissions to specific source sectors. We will consider current technological

capabilities and limitations, and the need for quantitative assessment of methane emissions from other fossil-fuel harvesting activities beyond high-volume hydraulic fracturing.

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