The Presence of Methane in the Four Corners

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Introduction & Description of Ecosystem

Methane, also known as CH_4 is a gas that is colorless, odorless, non-toxic, and highly flammable. It is a component of natural gas, and is found in underground coal beds. The transportation and storage of oil is also a large source of methane emissions. Currently, the Four Corners area has the highest concentration of methane in the United States. On their website, the San Juan Citizens Alliance notes that NASA and the University of Michigan both released reports in 2014 on the issue of methane in the Four Corners. The website explains that "methane, a powerful greenhouse gas, is far worse than carbon dioxide for the climate," and adds that "methane alone is not a direct public health issue, but it is commonly associated with the concurrent release of volatile organic compounds (VOCs) and other toxic pollutants." Although methane doesn't have direct health effects for humans, it is a greenhouse gas. Greenhouses gasses trap the sun's heat, which warms the atmosphere over time, causing global warming. This is also called the greenhouse effect. Methane is even more effective at trapping heat than carbon dioxide, which is another common greenhouse gas. Methane does not stay in the atmosphere for as long as carbon dioxide, which is why it doesn't receive as much attention. However, it's effects can be just as severe, if not more. Methane is negatively impacting the environment by increasing the severity of climate change and toxic pollutants.

'The Four Corners' is the nickname given to the area where Colorado, Utah, Arizona, and New Mexico all come together. This region's predominant ecosystems include: Riparian and/or Aquatic, Pinyon-Juniper Woodlands, Montane and Subalpine Forests, and Drylands.

"Biotic factors" are the living parts of an ecosystem, such as plants, animals, and bacteria. "Abiotic factors" are the nonliving parts of an ecosystem. Sunlight, temperature, gas, and water are all examples of abiotic factors in an ecosystem. The abiotic and biotic factors of Riparian and/or Aquatic ecosystems vary based on their location. Generally, the biotic factors of aquatic ecosystems include bacteria, primary producers, insects, fish, and other various vertebrates and invertebrates. The abiotic factors of this ecosystem include water flow, temperature, light, chemistry, and substrate. The Green River, Colorado River, and the Chama River are all examples of Riparian ecosystems in the Four Corners.

According to the website www.tarleton.edu, the Pinyon-Juniper Woodland ecosystems biotic factors include "the pinyon pine and oneseed juniper, alligator juniper (*Juniperus deppeana*), Gambel oak, and an occasional ponderosa pine 'round out' a woodland community with a sparse understory of short- and mid-grasses," among many other plants. Abiotic factors include sunlight, temperature, and precipitation, geologic formations, and methane. Mesa Verde National Park is an example of Pinyon-Juniper Woodlands in the Four Corners.

Montane and Subalpine ecosystems' abiotic factors include sunlight, temperature, wind, permafrost, and a fair amount of geological structures. Plants and animals are the biotic factors of this ecosystem. These

factors may include bryophytes, lichens, mule deer, elk, black bear, and red squirrel. Woodland Park, Wilkerson Pass, and Manitou Springs are all locations of Montane and Subalpine ecosystems in the Four Corners area.

The Dryland ecosystem has many abiotic and biotic factors. National Park Service states that the following are found in a Dryland ecosystem: "landforms of the dryland systems include deep and sparsely vegetated canyons, extensive mesas, lava beds, and slickrock." The biotic factors include a variety of shrubs and grasses, along with mostly lizards and invertebrates. Bandelier National Monument and Canyon De Chelly National Monument are two examples of the Dryland ecosystem found in the Four Corners.

Each one of these ecosystems' abiotic factors includes methane, and therefore these primary ecosystems are all affected by the high concentration of it in the Four Corners. To expand on its negative effects, methane is a concern to this area because of its high efficiency and ability to trap heat into the atmosphere, thus acting as a dangerous factor for climate change. Climate change will subsequently affect the abiotic and biotic parts of these ecosystems, including humans. The *Environmental Defense Fund* website states that "methane is 84 times more potent than carbon dioxide." The severity of this greenhouse gas brings us to inquire about important information. Asking the question "why is there a 'methane bubble' over the Four Corners area?" is essential in understanding what can be done to prevent or eliminate high methane concentrations in this location.

Research and Data

For many years, coal, oil, and natural gas have been mined in the Four Corners area. The general public was largely unaware of the effects of this mining until imagery was taken from space, between 2003 and 2009. The images showed a high concentration of methane in the Four Corners region. In the spring of 2014, "a swarm of scientists under the aegis of the National Aeronautics and Space Administration and National Oceanic and Atmospheric Administration, descended on the region." They planned to further map the methane hotspot and conduct more research on the source of methane. In 2016, they released a report titled *Airborne methane remote measurements reveal heavy-tail flux distribution in Four Corners region*. This report identified 245 sources of methane in the Four Corners region. Most of the emissions come from oil and gas infrastructure. There are some natural sources of methane, including the Fruitland Formation. This is a commonly mined geologic feature, but it also releases methane naturally.

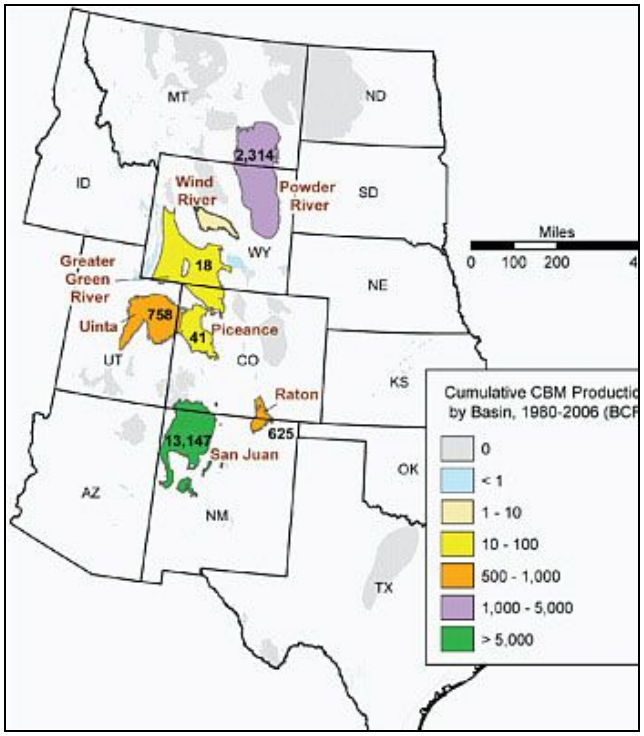

Figure 1

This map depicts the amount of coalbed mining (CBM) in the Western United States. This is significant because coal beds (most commonly found in the fruitland formation) contain large deposits of methane gas. The methane is trapped in the pores of the coal. Coalbed mining uses a water based solution to force the methane out of the coal for use as natural gas. This image makes it clear that the San Juan Basin, located towards the bottom of the map, is particularly laden with natural methane.

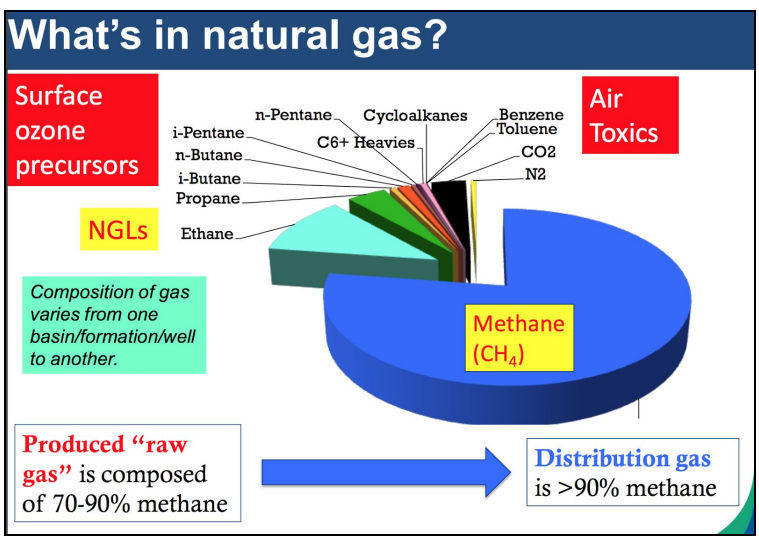

Figure 2

This infographic shows the composition of natural gas. As you can see, methane is a very prevalent component of natural gas. When natural gas is mined, methane can also be released into the atmosphere or burned, which releases carbon dioxide.

Figure 3
The San Juan Basin is a 4,600 square mile piece of land in the Four Corners area. The bowl like nature of the San Juan Basin traps the methane, because methane gas is five times denser than air. As we saw in *Figure 1*, methane is also common in other basins.

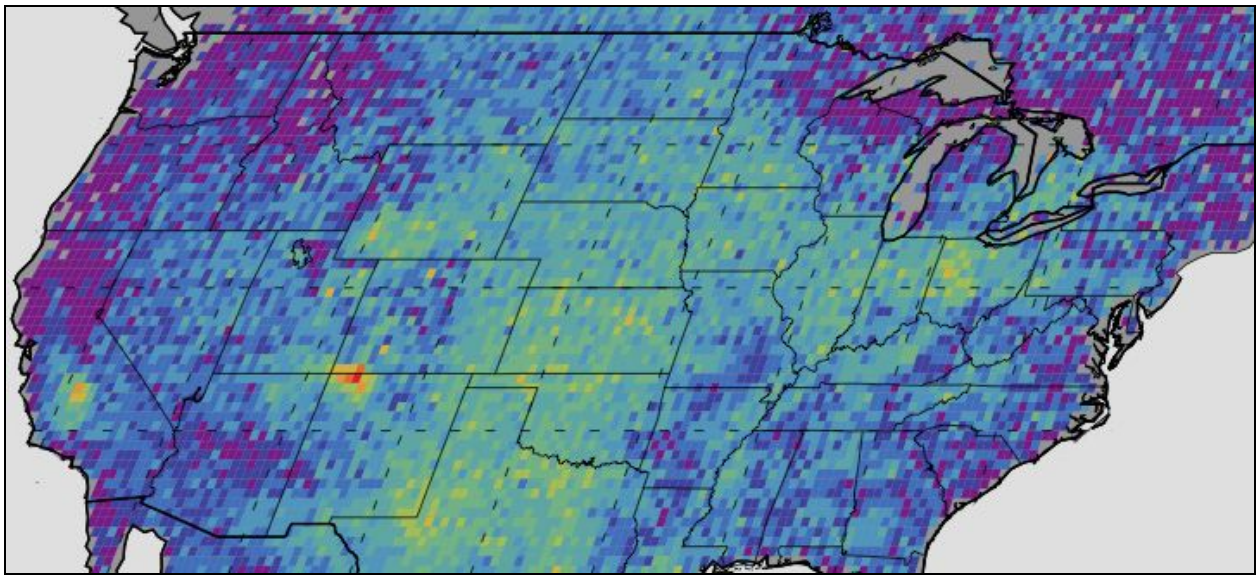

Figure 4
This image depicts satellite data collected during NASA's study. It shows the concentrations of methane gas throughout the United States. You can see the bright orange and red spots in the Four Corners area, indicating abnormally high levels of methane in the atmosphere.

Possible Solutions
The high concentration of methane in the Four Corners region has become a major topic of uncertainty for residents. Although the sources of this large-scale methane plume are not widely agreed upon, it is likely that contributors include seeps from geologic formations, oil and gas pipelines and drill sites, and hydraulic fracturing sites. In the wake of NASA's study, a few emissions sites have been cleaned up. During their surveying and analyzing, NASA identified four seeps that originated from pipelines and

reported them to the operating company. However, many mining companies continue to vent gases without consequence or hesitation.

When it is clear that methane originates from a man made source, it can be reported and contained. However, there is still much to be discovered about where methane comes from and what has caused the high concentration of methane in the Four Corners area. In an article written by Jonathan Thompson for the *Earth Island Journal*, it states "The scientists working to decipher the methane mystery remain mum when it comes to specific regulations, but they have discussed what they think needs to be done. 'If natural gas is to be a 'bridge' to a more sustainable energy future,' wrote Kort, Petron and several other researchers in a paper published by Science last fall, 'it is a bridge that must be traversed carefully: Diligence will be required to ensure that leakage rates are low enough to achieve sustainability goals.'" More research on the sources of methane is the only way that we will be able to understand it's impact and appropriately take action to prevent methane leaks.

The Environmental Protection Agency (EPA) and the Bureau of Land Management (BLM) have both written rules that will regulate methane emissions. The EPA made updates to the New Source Performance Standards (NSPS). As their website states, "Under the President's *Climate Action Plan: Strategy to Reduce Methane Emissions* and the Clean Air Act, EPA has issued final updates to the NSPS that curb emissions of methane and volatile organic compounds from additional new, modified and reconstructed sources in the oil and gas industry." However, their regulations only apply to "new and modified oil and gas facilities," while most of the oil and gas infrastructure in the Four Corners already exists. The rules proposed by the BLM would regulate already existing oil and gas facilities, yet these regulations have not yet been implemented. The White House also released a report in 2014 titled *Climate Action Plan: Strategy to Reduce Methane Emissions*. This report outlines ideas for reducing methane, and also stresses the need for more research surrounding the issue.

The presence of methane in the Four Corners is indisputable. However, we can reduce our impact. Further research, investigation, and regulation will all be necessary components to preventing methane seeps and increased methane concentration in our atmosphere in the future.

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