Aliso Canyon, methane, and global climate

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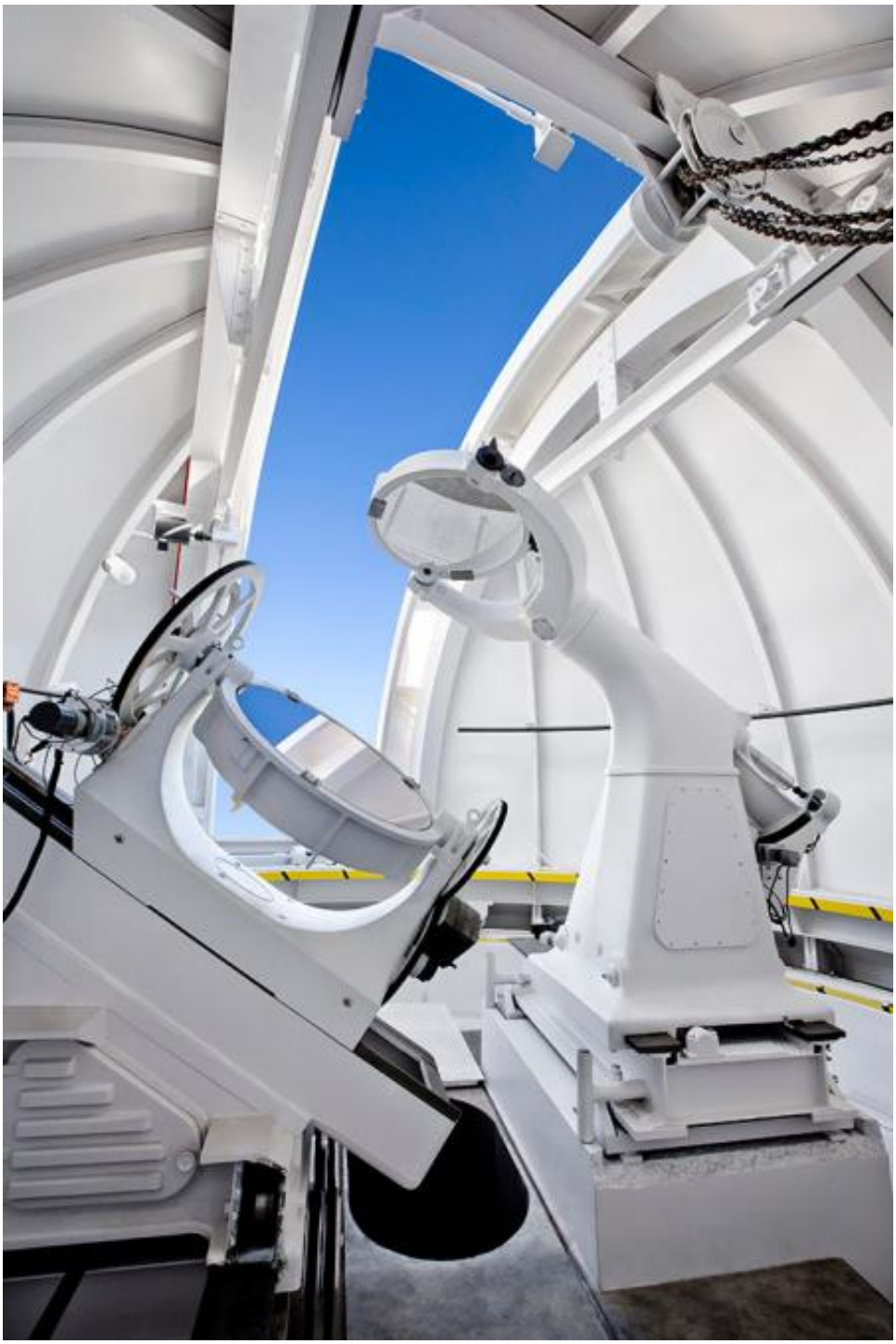

Methane and ethane—two of the major components of natural gas—are measured above the Caltech campus using a remote sensing instrument that utilizes the historic solar telescope located on the roof of Caltech's Linde+Robinson laboratory. Credit: David Wakely for Caltech

On October 23, 2015, the Aliso Canyon underground storage facility for natural gas in the San Fernando Valley—the fourth largest of its kind in the United States—had one of its wells blow out, leading to a large release of methane. The leak was not fully under control until February 11, 2016. In the interim, residents of nearby neighborhoods were sickened by the odorants added to the gas, thousands of households were displaced, and California's governor declared a state of emergency for the area. The story made international headlines; the BBC's headline, for example, read, "California methane leak 'largest in US history.'"

The leak was indeed large and undoubtedly difficult for the residents of the area. However, Caltech's Paul Wennberg says there is also a bigger picture to keep in mind: enormous methane and carbon dioxide (CO_2) emissions occur all the time, with troubling implications for global climate. Wennberg is Caltech's R. Stanton Avery Professor of Atmospheric Chemistry and Environmental Science and Engineering, executive officer for Environmental Science and Engineering, and director of the Ronald and Maxine Linde Center for Global Environmental Science.

We recently sat down with him to talk about methane emissions and how to put the Aliso Canyon event into perspective.

What was your involvement with the Aliso Canyon event?

We have a greenhouse gas remote sensing system here at Caltech that is part of TCCON—the Total Carbon Column Observing Network. The day after the Aliso Canyon leak started, we observed something really weird in the air above Pasadena. There was a large, big plume of methane and ethane gas that came over. We now know that it was from the Aliso Canyon facility. We are providing data for the final analyses of

the leak.

In the past you have suggested that the methane emissions from Los Angeles are much larger than was previously included in models.

Right. Thankfully, models are now catching up as we learn more from the data.

What does the Aliso Canyon event suggest about Los Angeles's methane emissions in general?

Aliso Canyon was a very dramatic event. Everyone heard about it worldwide. The leak continued for about 100 days, and yet it only doubled the amount of methane being emitted by LA during that period. This was a tragedy for the people living next to it, who had to deal with horrible nausea and other side effects of the chemicals associated with the natural gas. But from a climate point of view, the methane leak was actually quite trivial.

There are enormous amounts of methane being released into the atmosphere globally as a result of human activity. That is certainly true of LA, but as far as climate goes, it doesn't matter whether it's released in LA or New Zealand. On the timescale that methane sticks around in the atmosphere, it gets well mixed and affects the entire planet.

How much methane is emitted per year?

About three hundred teragrams [Tg; one teragram is equivalent to one billion kilograms] of methane are emitted every year by people and the activities of people, like agriculture and energy. Los Angeles emits about 0.4 Tg. That means that of the human methane emissions, LA as a total is one part in a thousand—not nothing, but a pretty small amount.

For perspective, Aliso Canyon emitted around 0.1 Tg. It was a big event, but what it really illustrates is how big a challenge we truly face. There are many sources emitting methane into the atmosphere and they are very diffuse. Reducing them will require hard work on many, many fronts. So it's not just, "If we solve this one problem, everything will be beautiful in the world."

You could imagine the response to the Aliso Canyon leak might be that we would all of a sudden focus all of our efforts trying to prevent leaks in natural gas storage facilities. That would not be the right answer from a climate perspective.

How should people go about eliminating methane emissions?

There is not "one" fix. Each source requires a different strategy for mitigation.

First, there is fixing leaks in the pipelines and storage facilities.

Then, it turns out that ruminants like cows and sheep produce a lot of methane—probably a third, if not more, of the human emissions. A paper about this, recently in Science, suggests that an important part of the recent increases in methane is coming from agriculture. Depending on what you feed these ruminants, they produce less methane. They eat grass, but they can't metabolize it: they have a fermenter going in their bellies—a whole microbiome that breaks the grass down into smaller things like acetate that they can metabolize. Depending on the microbiome of their guts, the cows and sheep make more or less methane. And it turns out that you can manage this.

Then there are the wetlands used for rice agriculture. Methane is

produced anaerobically—in places with no oxygen—by Archaea. If you have a flooded rice paddy, the methane is produced at the roots and is transpired through the rice plants into the atmosphere. Quite a few studies now show that if you can change your rice agricultural practices to allow the fields to dry periodically, the methane emissions drop hugely.

If you were able to fix all of these things what would the impact be in terms of climate change?

If we could really knock the methane emissions back to what they were before people started emitting methane, it would be a large change. It would be a half a watt per meter squared. The total global warming would drop by around 25 percent.

How does the importance of reducing methane emissions compare to the importance of reducing carbon dioxide emissions?

Globally, methane is important. It's maybe a third of the climate forcing of CO2—that is, the increase in methane has contributed about one third of the total change in Earth's climate over the last 100 years. In terms of climate impact, however, the methane emissions from people in Los Angeles are absolutely dwarfed by their CO2 emissions—all of our driving, going on airplanes, and everything else that we do. Still, if we are to reduce our global warming potential and the amount of greenhouse gasses we emit to the atmosphere, methane has to be part of the equation.

We like to think that we can solve these problems by fixing singular events, but climate doesn't work that way. We're talking about the emissions of 7 billion people. If it were that this was produced by 100

events like Aliso Canyon, this would be a simple problem: we solve the 100 problems, and we're done. But it's all of us, and it's all of what we eat, it's all of the energy that we use, it's all of the miles that we drive. It's a much more complex problem.

What work is your group currently doing in terms of methane?

One of the things we've been doing is long-term monitoring. Natural gas is mostly methane (CH4) but there's also ethane (C2H6) in it and this provides a way of separating the signature of methane emitted from agriculture, which has no ethane, and emissions from natural gas, which does.

Over the last five years or so, the production of oil in the United States has increased hugely, and associated with that oil production is natural gas, and therefore methane and ethane. Traditionally, most of the ethane produced at a wellhead was pulled off and sent to the plastic industry. With the changing oil production, the market has become flooded in ethane: there's simply not enough plastic to be made. When the industry can't sell the ethane to the plastic industry, they simply leave it in the natural gas. We see this in the natural gas delivered to Los Angeles. Five years ago natural gas had about 2 percent ethane. Now it's 5 percent—it's more than doubled. What we've seen—and this has nothing to do with Aliso Canyon—is that over the last five years, the amount of ethane in the air over Pasadena has increased.

That's important because it tells us that a significant fraction of the methane that's being released in LA is coming from natural gas brought into Los Angeles. This has been a topic of a lot of debate. Is the big methane emitter the oil production down in the Long Beach area? Is it waste treatment plants? Is it garbage dumps? What we find is that about

half of all the methane emitted in this part of LA is gas that originally came in on a pipeline.

How do you know that?

We actually know from the gas company how much ethane is in the natural gas. They report this publically from one of their storage fields and this matches the ethane in samples of the natural gas coming into our buildings.

Are there other projects under way at Caltech to study methane emissions?

Christian Frankenberg [associate professor of environmental science and engineering at Caltech and a JPL research scientist] has been leading an effort to build remote sensing instruments that allow imaging of methane plumes. Using small spectrometers on airplanes, he has flown over areas where you might have a lot of methane emissions and identified individual sources. Last year they were able to find individual pipelines that were leaking in Colorado and in New Mexico. They found several big leaks from pipelines and were able to tell the pipeline operators, who shut them down and fixed them.

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