Researcher explains the main source of a rare but destructive greenhouse gas

March 14 2022, by Danielle Underferth

A residential property subject to tent fumigation or "tenting", a process in which the property is sealed over with a canvas and filled with a pesticide gas for a number of days in order to kill pests such as termites and cockroaches. Los Angeles, California. Credit: Mfield, Matthew Field, http://www.photography.mattfield.com/Wikimedia Commons, CC BY-SA 3.0

Termites are destructive, and notoriously hard to kill. Structural

fumigation—tenting a house and piping in chemicals to kill the bugs—is the most effective way to do it.

One common chemical used for termite fumigation is sulfuryl fluoride (SO_2F_2), the only fumigant approved by the EPA for use in residential structures. Sulfuryl fluoride is popular because it is relatively cost-effective and does not contribute to ozone destruction, but it also happens to be a potent greenhouse gas that can remain in the atmosphere for decades, contributing to climate change.

To get a better handle on the prevalence and location of sulfuryl fluoride in the atmosphere, as well as its possible impact, a team of researchers led by Dylan Gaeta, a Ph.D. student in the Whiting School of Engineering, used atmospheric observations from the National Oceanic and Atmospheric Administration to show that the large majority of sulfuryl fluoride emissions in North America came from California in 2015–2019. Emissions were especially large from the Greater Los Angeles Area, where structural fumigation for termites is common. Their findings were recently presented at the American Geophysical Union's fall meeting.

We spoke with Gaeta about his research into the use of sulfuryl fluoride, and the implications for public health and climate.

Why did you choose to study this?

I first heard about the sulfuryl fluoride problem from my Ph.D. advisor, Scot Miller. He had run a preliminary atmospheric inversion using NOAA data, and I remember him showing that the emissions map of SO_2F_2 "lights up like Christmas" over California. This was around the time when I first started my Ph.D., and I thought the problem sounded interesting and policy-relevant, so I picked up the project and have been working on expanding Scot's preliminary work to finer spatial scales and

daily time scales. I find there is usually cause for concern when an entirely human-made chemical is accumulating in the atmosphere, especially in the case of a potent greenhouse gas like sulfuryl fluoride.

Why is this problem concentrated in California?

California's year-round warm climate is favorable for termite colony growth, both indoors and in nature, so it is very common for buildings there to have termite infestations that require fumigation.

Termites also can be found in the Southeast, especially in Florida, where the climate is also conducive to termite colony growth. Unfortunately, NOAA does not operate a greenhouse gas monitoring station downwind of Florida, and so it is difficult for us to infer much about sulfuryl fluoride emissions from there. NOAA does operate a tower in South Carolina, but concentrations of sulfuryl fluoride, which would indicate large emissions, are rarely detected at this lone Southeastern site. However, it is still possible that fumigations occurring in Florida could be swept up and carried over the Atlantic Ocean without being detected at the closest NOAA monitoring sites.

In addition, California is the only state that publicly releases a statewide record of sulfuryl fluoride use.

Aside from being a greenhouse gas, is sulfuryl fluoride bad for human health?

The gas is often referred to as a pesticide or an insecticide, but more generally it is a biocide: It will kill all living organisms that are exposed to it at sufficiently high concentrations for a sufficiently long period of time. That includes humans, pets, plants, and wildlife. The EPA has set an exposure limit of 1 part per million for sulfuryl fluoride, and

fumigators must ensure that every room in a fumigated structure falls back below 1 ppm before humans and pets can reenter. There have been several documented cases of inadvertent deaths caused by sulfuryl fluoride fumigations, and the EPA is currently reviewing public health and safety regulations for its use.

What are the climate implications for sulfuryl fluoride use?

Sulfuryl fluoride is a potent greenhouse gas that is entirely human-made, with no significant natural sources. The buildup of this gas in our atmosphere is an entirely human-caused problem. Sulfuryl fluoride was first discovered in ambient air in La Jolla, California. This discovery prompted a series of studies into the chemical and physical properties of the gas, including an investigation of potential removal mechanisms and quantification of the global warming potential. The results of these seminal studies were published in 2008–2009, with the main takeaway that sulfuryl fluoride has a much longer atmospheric lifetime than initially thought: 36 (plus or minus 11) years.

With such a long lifespan in the atmosphere, the global warming potential was revised upwards to 7,510 over a 20-year interval. In other words, 1 ton of sulfuryl fluoride traps as much heat in the atmosphere as 7,510 tons of carbon dioxide. After these studies were released, the Intergovernmental Panel on Climate Change added sulfuryl fluoride to its list of greenhouse gases in 2013, and the California Air Resources Board added the chemical to its list of short-lived climate pollutants. However, despite the evidence from the 2008 study that sulfuryl fluoride is a potent greenhouse gas, global emissions of the gas have continued to rise. The gas has been left out of most major greenhouse gas inventories and emissions reductions targets.

What real-world impact do you hope this research will have?

Our main goal is to increase awareness of sulfuryl fluoride, what it's used for, and what the dangers of its use are. We would also like to see sulfuryl fluoride included in future greenhouse gas inventories at the national, state, and local levels. Keeping track of where and how much of the gas is used is a crucial step to rein in emissions. Our research shines a spotlight on California, which has arguably been a world leader in greenhouse gas emissions reductions efforts. However, California's large sulfuryl fluoride emissions are a prime example of how uncounted emissions can threaten hard-earned progress toward emissions reductions goals.

At the local level, there are potentially steps that governments and fumigators can take to minimize the amount of sulfuryl fluoride that escapes to the atmosphere during fumigation. At the national level, it is important that the EPA properly characterize the gas as a greenhouse gas and include the compound in its Greenhouse Gas Inventory. At the international level, SO_2F_2 was included in the latest report from the Intergovernmental Panel on Climate Change, but hasn't been included in any international treaties that aim to curb global emissions, including the 2015 Paris Agreement. As SO_2F_2 grows in popularity worldwide, it becomes increasingly important to monitor and regulate how the gas is used and how much ends up in the atmosphere.

Provided by Johns Hopkins University