

COW BURPS SEEN FROM SPACE?

PAUL LOVATT SMITH reassesses satellite images of methane leaks from dairy farms.

Methane from cow burps seen from space for the first time”.¹ Under headlines like this a flurry of media articles in early 2022 announced that methane emissions from enteric fermentation had been detected from space for the first time, by a new generation of satellite instrumentation. The operators of the satellites identified the source as cattle feedlots in the Central Valley of California, near Bakersfield. The emissions from all five were estimated at 5,000 tonnes of methane per year.²

Atmospheric concentrations of methane, a powerful greenhouse gas, have increased by two and a half times since the industrial revolution, contributing significantly to global warming. With enteric fermentation and manure decomposition from ruminant livestock blamed by climate science for more than a quarter of all man-made methane emissions, is this more bad news for livestock farmers?

Not necessarily. Of the tens of thousands of other man-made emissions which these satellites have detected worldwide over a period of six years, the Bakersfield detection is the only one attributable to cattle. On top of this, the source of the methane appears to be the industrial processing of manure, rather than any natural biological phenomenon such as cow burps. Far from confirming the long-held scientific consensus that ruminant livestock are one of the main culprits, this new data suggests that their contribution could have been over-estimated.

Satellite Sniffers

The Bakersfield cattle emissions were detected by Canadian company GHGSAT, a pioneer in high-resolution remote methane detection, who launched their first satellite in 2016 and currently have five satellites mapping the entire globe. Previous satellite instrumentation was only able to detect emissions over large areas, at a resolution of several kilometres, and hence was unable to differentiate between individual sources. The new detectors have a resolution of 25 metres, which is 100 times finer than previous instruments. This huge leap forward in detection accuracy enables methane emissions from individual sources to be pinpointed, and their emission rates estimated.

GHGSAT’s instruments have been measuring human-caused methane emissions since 2016. In that time, they have identified tens of thousands of major emissions around the world. Recently they published a *Methane Emissions Report* for 2021, summarising the results of their global evaluation.

In 2021, GHGSAT surveyed over 100,000 sites in 47 countries, covering over a million square kilometres. They estimate that a total of 143 million tonnes of methane was emitted from these sites representing 39 percent of all man-made emissions. Three quarters of these emissions were interpreted as coming from fossil fuel production (oil, gas and coal), and one fifth were related to landfill sites. The remaining five percent is described as “other”. The report makes no mention of agricultural sources or of ruminant livestock.

Some case studies which use GHGSAT data have already been published in the scientific literature. For example, a 2019 study of a large and persistent emission from a gas compression station in Turkmenistan, Central Asia, estimates an annual leakage rate of 142,000 tonnes of methane per year, 28 times greater than the Bakersfield emissions.⁴

All such publications to date concern emissions from fossil fuels or landfill; there seem to be none about emissions from agriculture, let alone ruminant livestock farming. So, the Bakersfield case appears to be the only confirmed satellite detection of cattle emissions, among tens of thousands of human-caused methane emissions detected worldwide over a period of six years. As the Turkmenistan example shows, some of these are more than an order of magnitude larger than the Bakersfield one.

Given that climate science estimates that over a quarter of all human-caused methane emissions are coming from ruminant livestock the almost complete absence of detections of this type of methane is puzzling. Is it because GHGSAT focuses on industrial emissions? Or perhaps most cattle emissions



Former Turkmen President Niyazov in 2005 opening a compressor station at the Korpezhe gas field, source of the world’s largest leaks of methane. Cause for concern indeed, but what about the methane emissions attributable to those sheepskin hats?

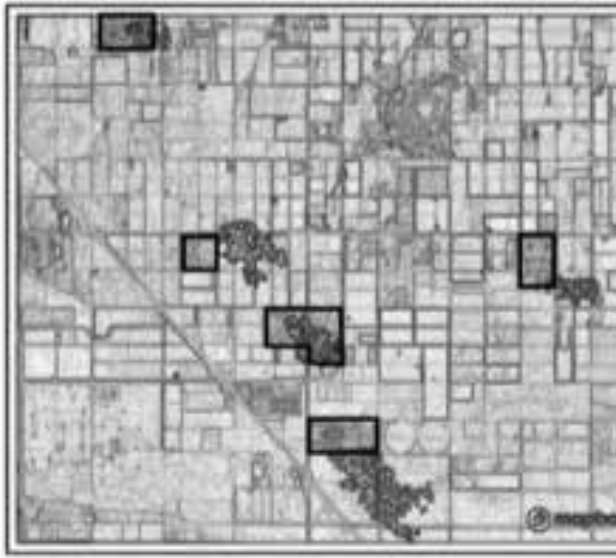
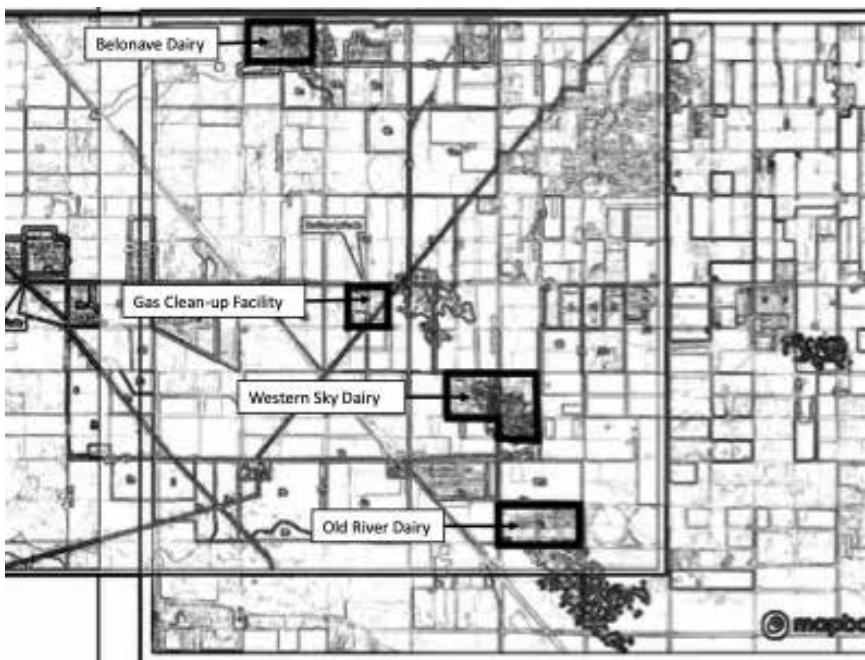


Fig 1 GHGSAT image showing clouds of methane adjacent to feedlot farms (outlined in black) near Bakersfield, CA.



Fig 2: Map of Kern County Biodigester Project. Numbers indicate participating farms.

Fig 3, below: the two maps superimposed, showing the four methane gas plants. Area of image approx. 150 km².



are too dispersed to measure accurately? Brody Wight, of GHGSAT is quoted as saying:

“Compared with energy and other pollution sources, the challenge with cattle is that their emissions are more diffuse and whipped about by the wind, making them difficult to track from ground meters”.⁵

Does this also make them more difficult to detect by Satellite?

On the other hand, could it be because cattle emissions are lower than forecast, so they are not detectable in any significant quantity? As yet, nobody in the scientific community seems to have addressed these questions.

Big Dairy

With unanswered questions like these, I decided to have a closer look at the Bakersfield methane detections. What came out of this research was a bit of a surprise.

In GHGSAT’s press release of 2 May 2022 the methane emissions are graphically displayed on an accompanying satellite image (Figure 1). The image is convincing, with the emissions clouds consistently offset to the SE, presumably downwind, from the location of individual feedlot farms.

The term “feedlot” implies that the farms produce beef cattle. Further investigation revealed that this part of California, Kern County, is famous for its large intensive dairy farms. They are some of the biggest in the world, with an average of around 3,000 milking cows per farm, housed in feedlots around a central milking and processing shed. A closer look on Google Earth reveals that 4 out of the 5 methane clouds are next to such dairy farms and only one is next to a conventional beef-type feedlot.

Whether dairy or beef, feedlot farms generate a huge amount of manure, the disposal of which causes problems with water and soil pollution. In recent years, many of them have installed biodigester facilities to process and harness energy from the manure. In the area where the methane clouds have been detected there is one such project involving several dairies, called the Kern Dairy Biogas Cluster. This project is run by a company called California Bioenergy who have published details on the project (Figure 2). The potential of the project is a respectable 12 MW of electricity. The energy source is the product of anaerobic digestion of manure – methane gas (see box next page).

This project has involved the construction of large facilities, with manure pits the size of several football pitches covered over with airtight membranes to generate the methane from anaerobic decomposition, connected by pipelines which lead to processing plants and power stations.

Could the methane gas detected from space be leakage from such facilities? Although it’s industrially inefficient, it’s not unreasonable to expect that such large covered pits would not be totally airtight;

it is even possible that impure methane could be deliberately vented from processing plants.

Tellingly, four out of five of the methane clouds identified by GHGSAT match exactly to facilities in the project. Three clouds are adjacent to biodigester pits and one is adjacent to the “gas clean-up facility” labelled in the centre of Figure 3. The remaining eastern-most cloud is from a farm that does not have biodigester facilities. Here it appears to be coming from slurry pits which together cover an area of approximately four hectares.

It seems highly likely therefore that most, if not all, of the methane detected from space in this instance is leakage from the industrial process of anaerobic digestion or emissions from slurry pits, — ie from the storage and processing of manure, not from cow burps, as GHGSAT have interpreted. I contacted GHGSAT about this alternative hypothesis and received replies expressing interest but containing neither denial nor confirmation.

Cloud of Unknowing

So, out of tens of thousands of methane leaks detected by the new satellite technology, there is only one published example attributed to ruminant farming, and here it appears that most of the emissions are coming from the deliberate generation of methane on an industrial scale, rather than directly from the cows’ stomachs.

Does this suggest that the volume of methane emitted into the atmosphere by cattle through enteric fermentation in cattle may have been exaggerated? Absence of evidence is not evidence of absence, but it does beg questions.

When climate change became a global concern in the 1990’s, it was important for climate science to identify the sources of an alarming increase in atmospheric methane since the industrial revolution. Fossil fuel extraction and landfill waste decomposition were obvious culprits but the estimates from these sources fell well short of the measured increase. It was thought therefore that some biological sources connected to agriculture could also be contributing.

Laboratory experiments had accurately measured rates of methane emissions from ruminant livestock, from the processes of enteric fermentation and manure decomposition. These seemed relatively large but other measurement techniques were not yet available to identify and compare the full suite of man-made and biological methane emissions. It’s quite easy to put a cow in an airtight room and measure the gases given off. It’s much more difficult to do the same for an oak woodland or a tropical mangrove swamp. And as GHGSAT point out, when cows are outside in a field their emissions are diffuse and hard to measure from the ground.

Moreover methane is a relatively unstable gas and is broken down much more easily than carbon dioxide, in both the



Covered slurry lagoons at one of the farms participating in the Kern County biogas cluster, a joint venture between California Bioenergy, Chevron, and several California dairy farmers. Altogether 15 mega-dairies are signed up to deliver gas to a central gas cleaning and conditioning hub. The project received grants totalling \$17.6 million from California Climate Investments (CCI), part of the state’s “Cap and Trade” carbon offset scheme. CCI claim that thanks to these funds, these renewable energy schemes “capture and prevent the release of methane – a greenhouse gas 25 times more potent than carbon dioxide”.

However, as an Environmental Protection Agency study on the Kern Cluster explains, the methane is not captured, it is cultured: “manure is flushed with water into a lagoon system, where ambient temperature bacteria break down the manure releasing methane.” The evidence is that some of the methane so released, is then released into the atmosphere.

California Bioenergy: Plugging Dairies into a Renewable Future, EPA Webinar Presentation, 27 March 2019, <https://www.epa.gov>

Capturing Methane to Create Renewable Fuels in Kern County, California Climate Investments, 2021, www.caclimateinvestments.ca.gov

atmosphere and biosphere, by so-called sink processes. Methanotrophs are bacteria and similar organisms that metabolise methane as their source of carbon and energy, and are found in wetlands, soils, marshes and other environments where methane is produced. In other natural situations (such as oak woodland) methane-oxidising bacteria have recently been shown to reduce methane emissions by over one third. Similar processes may be happening with ruminant emissions under natural conditions, compared with laboratory measurements but as yet they are unresearched.⁶

This lack of understanding leads to large uncertainties in the authoritative Global Methane Budget.⁷ To illustrate: the phenomenon which the budget is trying to explain is an annual increase of around 17 million tonnes per year in the atmosphere; yet the uncertainty range for sinks is nearly 300 million tonnes per year. No scientist should feel comfortable with a model whose uncertainty range in one input is more than sixteen times larger than the property under investigation.

Ruminant Responsibility

The two-and-a half times increase in atmospheric methane in post-industrial times has been responsible for 23 percent of global warming, according to the Global Methane Budget. It is very important in terms of mitigation, that the true causes of this dangerous increase in methane are addressed as soon as possible.

This new satellite data adds to a growing body of evidence casting doubt on the way that climate science treats ruminant methane. Science is based upon the principle that theories and models require revision on the basis of new data. The

need for review and revision is especially acute in this case, where there is an apparent gulf between the reality measured and the theory predicted.

The scientific reasoning apportioning a quarter of all man-made methane emissions to ruminant livestock has always been questionable. It is hard not to conclude that there have been other forces at work here, including prejudice amongst some within the scientific community against meat and livestock farming in general.

Meanwhile the fossil fuel and landfill industries, which eclipse ruminant methane emissions in the new satellite data, appear to have escaped their full share of blame in some parts of the scientific world and in popular culture.

This may not come as much of a surprise to livestock farmers who are now used to being labelled as part of the problem in the environmental and climate crisis. It is particularly frustrating for the increasing number of farmers who believe that pasture-fed ruminants in a mixed farming system, (as opposed to the feedlot system operated in Bakersfield) are part of the solution to this crisis. Livestock farmers should be encouraged by the initial findings of this new methane detection technology. Now, what is needed is for the scientific community to step up to the plate and honestly re-examine its models and assumptions.

NOTES AND REFERENCES

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2. *Cow Burps Seen from Space*, GHGSAT, 2 May 2022, <https://www.ghgsat.com>
3. *GHGSAT_2021_Methane_Emissions_Report.pdf*, www.ghgsat.com
4. “Satellite Discovery of Anomalous Large Methane Point Sources From Oil/Gas Production”, D. J. Varon et al. 2019, *Geophysical Research Letters*, <https://doi.org/10.1029/2019GL083798>
5. Naureen Malik, *Cattle Burp Methane Emissions Measured From Space for First Time*, Bloomberg UK, 30 April 2022, www.bloomberg.com
6. Jeffrey, L.C., Maher, D.T., Chiri, E. et al. Bark-dwelling Methanotrophic Bacteria Decrease Methane Emissions from Trees. *Nat Commun* 12, 2127 (2021). <https://doi.org/10.1038/s41467-021-22333-7> One recent article describing tree and forest emissions contains a photo of a burning jet of methane emerging from a probe inserted into the trunk of an upland oak tree in Hungary. Methane production and emissions in trees and forests, K.R. Covey and J.P. Megonigal, *New Phytologist* (2019) 222: 35–51 doi: 10.1111/nph.15624
7. A publication authored by a large number of scientists from all over the world, which appears to be the definitive source on methane used by climate science. *The Global Methane Budget 2000–2017* Earth Syst. Sci. Data, 12, 1561–1623, 2020 <https://doi.org/10.5194/essd-12-1561-2020>



Photo: Tom Barron

Vegan Mendacity

The above poster is one of many plastered all over the London Underground, offering our Prime Minister a rather paltry sum by his standards if he goes vegan for a month. It is accompanied by the sort of statistical sleight of hand we have come to expect from anti-livestock campaigners. The poster claims that “the world’s five biggest meat and dairy companies together emit more greenhouse gases than Exxon, Shell or BP.”

The figures come from work carried out by the Institute for Agriculture and Trade Policy, GRAIN and the Heinrich Boll Foundation, based on FAO’s GLEAM data (last updated in 2010), and published in a report called *The Meat Atlas*.¹ The way they are used in the poster is misleading for a number of reasons.

(i) Nearly half of all these meat and dairy emissions (280Mt of CO₂eq out of 578 Mt) come from one company, JBS. Why? Largely because JBS is based in Brazil, where the beef and soya industries are responsible for massive deforestation. How much better it would have been if the advert, instead of asking Sunak to go vegan, demanded that he ban imports of Brazilian soya and beef.

(ii) Nearly half of the emissions attributed to cattle in *The Meat Atlas* are caused by methane. GLEAM data uses the GWP100 methodology for equating methane emissions with carbon dioxide emissions, which is known to be inaccurate. Use of the more accurate GWP* metric would give very different results, though it is hard to say what exactly.² However, since the numbers of cattle in Europe, the USA and East Asia are declining, if anything they are now responsible for global cooling.

(iii) The majority of livestock emissions not caused by methane or deforestation are due to the burning of fossil fuels for energy, processing and fertiliser (some supplied by Shell, BP and Exxon). The adverts’ choice of statistics glosses over the fact that fossil fuels are responsible for about two thirds of all global warming, while the FAO’s GLEAM-based estimate is 14.5 percent for livestock.

(iv) *The Meat Atlas*, from which the advert’s statistics are taken, does not advocate veganism. It states, repeatedly, that the problem is industrialised livestock production: “More than one billion people around the world earn their living by KEEPING LIVESTOCK. Traditional and nature-friendly animal husbandry is coming under pressure from INDUSTRIALIZED AGRICULTURE”. It calls upon governments to “shift away from industrial farming, and to support better animal farming and healthy, plant-rich diets.”

The Land asked Generation Vegan, the body responsible for the advertising campaign, who it was who fronted the money, and they told us “an anonymous donor”, though we understand a number of musicians and media folk are behind the campaign. Why, one wonders, are there no posters persuading people to stop flying, ditch their car or cut down on their energy consumption?

1. *The Meat Atlas: Facts and Figures About the Food We Eat*, is available at <https://friendsoftheearth.eu> <https://www.iatp.org/supersized-climate-footprint>; Methodology can be found at IATP, *Big Meat and Dairy’s Supersized Climate Footprint*, 2017, <https://www.iatp.org/supersized-climate-footprint>
2. See S Fairlie, “A Convenient Untruth”, *The Land* 26, www.thelandmagazine.org.uk