



## CASE STUDY

# A comprehensive assessment of methane emissions in the Permian basin: the PermianMAP project

Environmental Defense Fund's (EDF's) [Permian Methane Analysis Project](#) (PermianMAP) was a monitoring and research project to provide transparent and accessible methane emissions data from one of the world's largest oil fields. The project was designed to use a variety of peer-reviewed techniques to monitor and quantify emissions, including: satellite-based regional estimates; ground-based vehicle measurements and helicopter-mounted optical gas imaging; stationary measurement towers and periodic aircraft mass balance flights; and aircraft hyperspectral imaging. This case study presents these monitoring efforts and discusses how resulting data was made available on a public website within days to weeks after data collection.

### Context

PermianMAP aimed to provide transparent and accessible methane emissions data from one of the world's largest oil fields, the Permian Basin of west Texas and southeast New Mexico, US. Oil and gas operations in this area accounted for [around 2.7 Mt](#) of methane in 2018 or about the same as the entire oil and gas industry in China or Algeria.



## Integrating multiple measurement technologies

PermianMAP was designed to use a variety of techniques to monitor and quantify emissions, attributing them to specific facilities and operators whenever possible. A key innovation was the distribution of resulting data on a public website ([www.permianmap.org](http://www.permianmap.org)) within days to weeks after data collection, as opposed to most scientific peer-reviewed efforts which take months to years for publication. Rapid publication of data and dissemination to relevant stakeholders (e.g. operators, regulators) was intended to drive direct mitigation, increase public awareness of the emissions problem, and increase accountability of operators within the region.

To conduct the measurements, EDF partnered with academic researchers and independent companies utilizing a collection of cutting-edge leak detection and emissions quantification platforms. Multiple campaigns were conducted throughout 2020 and 2021, with some measurements continuing afterwards. Measurements from the TROPOMI satellite were employed at the outset of the project to characterize baseline emissions from the basin and indicate sub-regions with higher emissions that could be the focus of finer approaches. These efforts found overall emissions to be the largest of any basin in the US: 3.5% of total gas production was being lost to the atmosphere.

Ground-based vehicle measurements using the EPA OTM-33A method were deployed to quantify methane and VOC emission rates at individual sites. This technique can detect very small emissions sources and, when paired with an infrared camera, can identify precisely which sites and components need repair. However, given the size of the basin with over 100,000 active wells and the time constraints, ground-based surveys using this method only covered a small sample of facilities.

Surveys based on helicopter-mounted optical gas imaging cameras were used to inspect and collect video footage at thousands of sites. These aimed to identify malfunctioning flares and other large emission sources. While these cameras did not quantify emissions, the videos collected identified which components were the source of the emissions and which malfunctions were present, enabling mitigation.

Five high-quality instruments continuously recorded methane concentration in the atmosphere at a series of cell-phone towers and other sites spread across the western half of the basin. Data recorded from these instruments fed into an atmospheric chemistry model and helped track the temporal evolution of mean methane emissions at the scale of weeks to months. Additionally, periodic aircraft mass balance flights collected in-situ measurements of methane concentration at the atmospheric boundary layer. The measurements from each flight were similarly synthesized by an atmospheric chemistry model to provide an alternative verification of regional emissions estimates for given days.

Lastly, two aircrafts carried remote sensing platforms throughout the basin to quantify emissions. The first surveyd 3-10 square kilometre circular regions encompassing a handful of sites, finding highly variable emission rates. Some measurements were below the methodological detection limit of about 10 kg/h. Others went all the way up to the largest emission source documented: a failure at a compressor station leading to continuous emissions over 12 metric tons of methane per hour. Due to the extreme size of this event, efforts were made to rapidly contact the operator and new measurements confirmed that repairs were made within about 24 hours of the source's identification. The second aircraft utilized hyperspectral remote sensing during two separate two-week campaigns throughout the core production regions in the Permian. Nearly 1700 plumes were detected from about 1000 different sources, yet many of these large point sources were highly intermittent, indicating comprehensive mitigation requires frequent monitoring.

## Lessons learned

There is no 'one-size fits all' approach to mitigating methane emissions from the oil and gas sector; comprehensive reductions can only be achieved by combining different measurement approaches. For example, measurements from the TROPOMI satellite identified regions responsible for the largest share of emissions, these maps did not align precisely with the highest production regions.

Early on, with the outset of the COVID-19 pandemic in the spring of 2020, a decrease in emissions of 60% was observed by the tower network from previously recorded levels. A part of this drop was related to a reduction in the number of new wells being developed and a decrease in flaring, but more than half of the decrease came from indirect improvements in the midstream system. A resulting [paper](#) suggests that under typical price conditions, the Permian Basin is in a state of overcapacity in which rapidly growing associated gas production exceeds midstream capacity and leads to high methane emissions.

The ground-based measurement team documented nearly 100 sources of emissions from individual wellsites, many of which came from low producing wells. These and other related data were recently [synthesized in a study](#) that indicates low production

wells account for about half of all wellsite emissions but only 6% of oil and gas production in the US. While individual large point sources observable by aircrafts represent actionable mitigation potential, significant reductions must also address the hundreds of thousands of low production wellsites which are generally not observable by aircraft or satellites. The helicopter surveys conducted over two years consistently documented unlit flares to be prevalent in all sub-regions of the basin and in both the production and midstream sector. Overall, 7% of active flares surveyed were completely unlit and another 5% exhibited poor efficiency with significant amounts of gas escaping through the flame or visible plumes of black smoke. These findings indicate that flaring is a major contributor to emissions in the Permian, likely representing at least 10% of total emissions.

Aircraft surveys frequently documented thousands of super-emitting sites throughout the basin. Mitigation actions were driven by attributing identified emissions to specific facilities and by disseminating the data directly to operators and onto a public website with imagery and detailed information of the plumes detected. See [Abatement Pathways](#) for more on how to mitigate methane emissions.



## Find out more

Monitoring and managing methane emissions



Curtailling flaring and venting: New Mexico Methane strategy



METHANE  
GUIDING  
PRINCIPLES

This case study was prepared and submitted by the Environmental Defense Fund and does not necessarily reflect the views or positions of all of the Signatories and Supporting Organisations of the Methane Guiding Principles.