Access to Monitoring Data Reduces Methane Intensity at Operational Oil and Gas Facilities

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Methane intensity is defined as methane gas emitted to the atmosphere per oil and gas product throughput at various steps in the supply chain. It is the standard metric used by industry stakeholders to assess methane emissions performance. Many studies have assessed the capabilities of methane emission measurement systems, but no studies have quantified the effect on methane intensity of oil and gas operator access to methane emissions data. In this study, methane emissions were measured with ("data-on") and without ("data-off") operator access to real-time methane emissions data and fugitive emission alerts. Across two U.S. producing basins, 46 well sites and production facilities were monitored. Basin 1 was monitored in data-on mode for the full 10-month duration of the study. In basin 2, operators had access to real-time data and alerts for 7.5 months, followed by ~1.5 months of data-off. During the data-on period, emissions decreased over time in both basins. However, following the pivot to data-off in basin 2, the trend reversed, with an implied methane intensity increase of >60%. Well sites emitted

disproportionately more than facilities. These tests suggest that operator access to continuous methane monitoring data at oil and gas production sites correlates with reduced methane emissions.

1. INTRODUCTION

Methane is a potent greenhouse gas with a global warming potential over 80 times that of carbon dioxide over a 20-year horizon, making mitigation of emissions a top priority for near-term climate action.[1] Methane emissions can occur during the production, processing, transport and distribution of oil and gas products due to process malfunctions, unoptimized system designs, and fugitive emissions.[2,3] While many studies have tested the efficacy of traditional and advanced methane emissions detection and monitoring solutions,[4–6] no study has yet tested the impact on industrial methane emissions of the operator having access to monitoring data. Monitoring systems do not, themselves, repair and mitigate emissions; oil and gas operators do. It is therefore important to test the impact on methane emissions of operator access to methane emissions data.

This study reports on the impact of operator access to emissions data, as directly measured in two phases: first, during a period of 7.5 months when the oil and gas operator had full access to data and alerts, and second, during a period of 1.5 months when the oil and gas operator was blinded to all emissions data and alerts. A control study was performed with 10 months of full data access in another basin. In this single-blind test format, the impact on overall methane emissions of operations access to real-time continuous emissions measurement and monitoring (CEMM) data was tested for the first time.

2. EXPERIMENTAL METHODS

2.1 LongPath Continuous Emissions Measurement and Monitoring

The LongPath Laser Emissions Sensing Network is designed to both quantify methane mass emission rates and continuously track abnormal or fugitive releases from industrial facilities, including oil and gas production, transmission, and distribution infrastructure.[7] To operate, the system requires collaboration from site operators for the installation of a laser transceiver and a set of low-cost retroreflective mirrors positioned around the infrastructure. A single LongPath node, consisting of one laser transceiver, can monitor multiple sites such as production or processing facilities, well pads, or compressor stations using two or more reflectors. By combining on-site meteorological measurements from an anemometer with atmospheric inversion models, the network autonomously identifies methane emission events, estimates their rates, and pinpoints their sources. Real-time automated alerting algorithms then notify operators of unusual or high emissions.

Methane concentrations in the atmosphere are determined using long-path laser absorption spectroscopy, where the laser light absorption at wavelengths corresponding to methane's quantum transitions is measured and translated into a path-integrated methane concentration.[8,9] The concentration observed by a downwind sensor, denoted $CH_{4\ ATMOS}$, reflects contributions from the ambient background methane ($CH_{4\ BG}$) as well as methane released from the site itself, including fugitive emissions (x_{FUG}) and other non-fugitive, non-target emissions sources (x_{NTE}). In Equation 1, A links emission sources to measured changes in atmospheric methane concentrations, ΔCH_4.

$$CH_{4\ ATMOS} = A(x_{NTE} + x_{FUG}) + CH_{4\ BG} = \Delta CH_4 + CH_{4\ BG} \qquad \text{(Eqn. 1)}$$

The LongPath method measures $CH_{4\ ATMOS}$ and background ($CH_{4\ BG}$) and solves for total emissions (ΔCH_4) directly.[8,10,11]

2.2 Operational Oil and Gas Sites

The tests were performed in two U.S. oil and gas producing basin. In Basin 1, 7 production facilities and 1 well site were monitored with one laser system (Basin1-Node1) and 1 production facility and 1 processing plant were monitored by another laser system (Basin1-Node 2). In Basin 2, 41 well sites and production facilities were monitored with three LongPath lasers for 9 months. Several LongPath lasers (nodes) measured the same site as another LongPath laser (node). Basin2-Node1 monitored 4 production facilities and 6 well sites, Basin2-Node2 monitored 5 production facilities and 8 well sites, and Basin2-Node3 monitored 10 production facilities and 8 well sites. Production facility or facility is used to refer to an oil and/or gas production facility with one or more storage vessels and equipment to gather crude oil, condensate, produced water, or intermediate hydrocarbon liquid from one or more offsite natural gas or oil production wells. Well site is used to refer to wellhead only sites and well sites with one or more pieces of production equipment, including reciprocating or centrifugal compressors or storage vessels.

2.3 Evaluation of the Effects of Operations Access to Continuous Monitoring Data

Some stakeholders assume that long-term, ongoing emissions monitoring may not be necessary for maintaining a low emissions profile, reasoning that once all leaks have been caught and fixed once, emission rates will remain low in perpetuity. It is also unclear whether operator access methane emissions data results in extra emissions mitigation or improvements to operational efficiencies for emissions reduction, beyond what is achieved with standard site visits and/or equipment telemetry alone. To shed light on these questions, emissions were measured for two sustained periods in which the operator had 1) full access and 2) no access to real-time data and emission event alerts. In total, roughly 469 site-months of measurement and monitoring data were collected across active oil and gas operations sites in the two basins. During all testing in Basin 1 and the first 7.5 months of testing in Basin 2, all data were provided to the operator in real time via the LongPath dashboard and API, and email alert and text message alerts were sent directly to operations personnel for all abnormal and fugitive emission events. This mode of data collection was designated "data-on" mode. In the final 1.5 months of monitoring in Basin 2, operator access to all alerts and data from the LongPath system was removed, amounting to roughly 63 total site-months of emissions collection in "data-off" mode. After the turnoff date, LongPath continued to collect emissions information about all sites with no change, but the operator ceased receiving any information about emissions from LongPath, including alerts for fugitive events. Evaluation of operator access to data was not protected from the Hawthorne effect, meaning the awareness of LongPath emissions observation by the operating teams could have affected operator activities or actions in the field.

3. RESULTS AND DISCUSSION

3.1 Impact of Monitoring and Data Availability on Emission Rates and Trends

For both basins, trends in emissions were assessed using daily, weekly and monthly averages. LongPath systems typically employ higher-frequency scanning during emission events, meaning data are collected more often during periods of higher emission rates. Emission events almost always span at least one day, given system time-to-alert plus operator time-to-repair. To remove potential effects of higher-frequency sampling during high-rate events, the raw emissions data were first averaged for each site and day, then aggregated to weekly and monthly averages per site and across sites.

Through the course of monitoring and measurement in both basins, emissions tended to decrease over the course of monitoring with data-on (operations access to real-time data and alerting), suggesting a relationship between access to emissions data and long-term decreases in emission rates. In Basin 1, the trend in the average daily emission rate across all sites was modestly downward at -0.10 kg hr^{-1} per month, with a standard error of 0.05. The trend was statistically significant ($p < 0.05$) but explained only a small portion of the variance ($R^2 = 0.02$). The daily mean emission rate per site in Basin 1 was 4.87 ± 2.20 kg hr^{-1}, meaning the observed trend could indicate a 25% reduction in emissions over a 12-month period with the addition of monitoring data.

As the operator continued to add sites to the monitoring network, the site count initially increased (see *Supporting Information*). To eliminate the possibility of trends resulting from the addition of sites through the monitoring period, stack summed mean emission rates were calculated for sites with uninterrupted data for every month of the monitoring period (7 sites for all 10 months in Basin 1; 35 sites for all 9 months in Basin 2) and every week of the monitoring period (4 sites for all 40 weeks in Basin 1; 8 sites for all 40 weeks in Basin 2) (Figure 1).

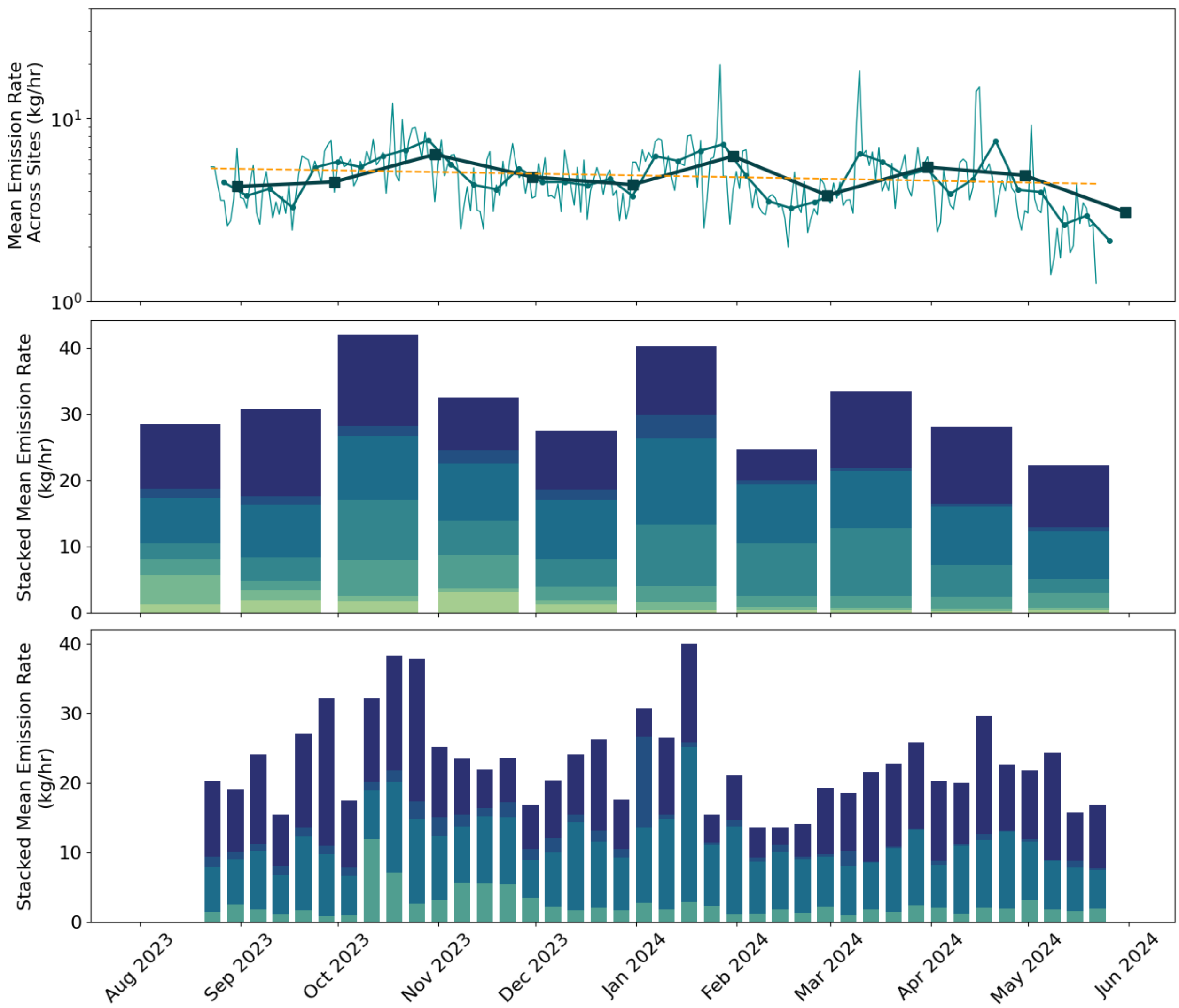

Figure 1. Top panel: Basin 1 mean emissions per site on a log scale for each day (thin teal line), week (circles and medium-width dark teal line) and month (triangles and thick, dark teal line) across all sites, with orange dotted line showing the trend of the daily data. Middle panel: Basin 1 stacked mean monthly emission rates per site for the 7 sites that had monitoring for all 10 full months of measurement. Bottom panel: Basin 1 stacked mean weekly emission rates per site for the 4 sites that had monitoring for all 40 weeks of measurement. Each color in panels 2 and 3 indicates the contribution from each site.

In Basin 2, the weekly and monthly trends before data were turned to data-off mode for the operator also showed reductions associated with the introduction of CEMM data to operations teams. The trend in the daily average emissions per site showed a decline of –0.30 kg hr^{-1} per month with a standard error of 0.15, and a low but significant coefficient of determination (R^2 =

0.02, $p < 0.05$). The daily mean emission rate per site in Basin 2 was 4.02 ± 4.09 kg hr^{-1}, indicating a possible 90% annual reduction in emissions with operator access to data, although emissions are likely to asymptote to a lower but consistent x_{NTE} with continuous monitoring over time.

Operations access to all data and fugitive emission alerts in Basin 2 was turned "off" for the operator on Friday, October 18th, 2024. Once the data was turned off for the operator, an increase in emissions was observed. The trend in emissions rates per site reversed to +0.47 kg hr^{-1} per month, with a standard error of 0.70 (R^2 = 0.01, p = 0.5). Overall, the average emission rate before the data was turned off was 3.43 ± 3.85 kg hr^{-1}, and after data was turned off for operations, it increased to 5.60 ± 4.30 kg hr^{-1}. The implied methane intensity of the increased emissions across the measured oil and gas production sites was a >60% increase when operator access to methane emissions data and fugitive emission alerts was removed.

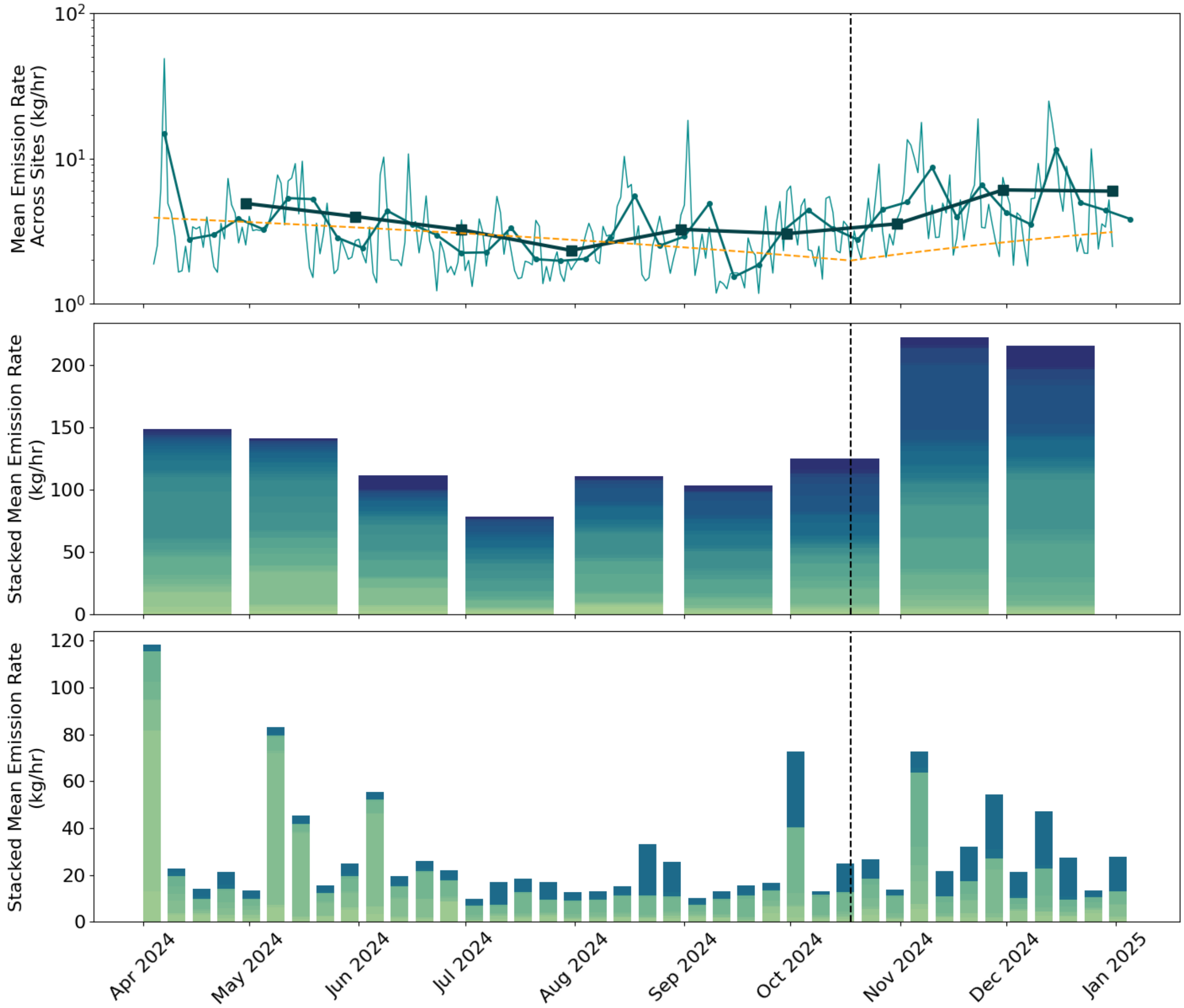

Figure 2. Top panel: Basin 2 mean emissions per site on a log scale for each day (thin teal line), week (circles and medium-width dark teal line) and month (triangles and thick, dark teal line) across all sites, with data-on and data off-trends shown as dotted orange lines. Middle panel: Basin 2 stacked mean monthly emission rates per site for the 35 sites that had monitoring for all 9 full months of measurement. Bottom panel: Basin 2 stacked mean weekly emission rates per site for the 8 sites that had monitoring for all 40 weeks of measurement. Each color in panels 2 and 3 indicates the contribution from each site. The vertical dotted black line in each panel shows the data turn-off date of October 18, 2024.

The transition from the “data-on” to the “data-off” period, when the operator no longer received data or alerts, occurred on October 18, 2024. This transition was clearly associated with an increase in overall site-average emission rates, as well as stacked mean emission rates across sites. The finding that emission rates increased after the emissions and alerting information that had formerly been made available to the operations were removed suggests that ongoing, real-time emissions data was strongly associated with lower-emissions operations.

During the data-on period, Basin 2 emissions events during the pilot period were frequently attributed (by the operator) to slop tank emissions. The slop tanks were only located on well sites in the pilot study. The well sites also had compression. Compared to the production facilities in the study, these smaller well sites contributed disproportionately to overall emissions, both before the data turn-off period and after the data turn-off period (Figure 3).

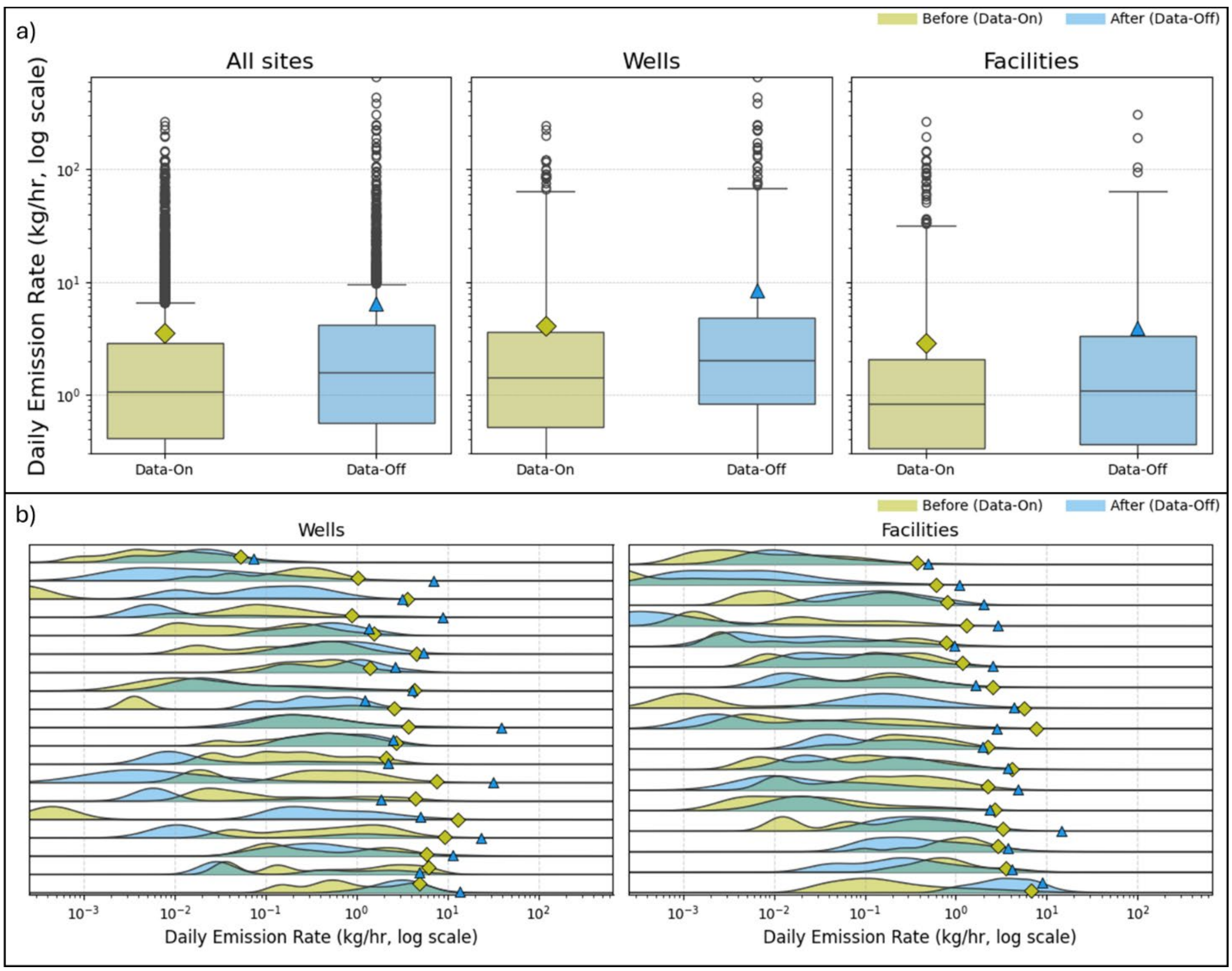

Figure 3. For Basin 2, panel a) box and whisker plots on log scale showing distribution of daily average emission rates for all sites, well sites and production facilities; and panel b) ridge plots

showing the distribution of daily average emissions by site. For all panels, data-on (yellow) and data-off (blue) means are shown with diamond (data-on) and triangle (data-off) symbols.

During emissions monitoring planning, well pads can be overlooked in favor of a stronger focus on higher throughput centralized production facilities, particularly given well pads may have near-daily visits from pumpers. The data from this study shows that, contrary to common expectation, well sites are equally or more so in need of fugitive emissions monitoring, even with frequent pumper visits to those sites. Overall, these findings provide strong evidence that quantified, high-frequency CEMM data for oil and gas operations can support important feedback to operations and sustained emissions reductions – reductions that may be reversed immediately upon cessation of the monitoring program.

3.2 Impact of Monitoring and Data Availability on Emission Event Frequency

The impact of data access on emission events is examined via the frequency and character of operational emission event alerts sent through the CEMM data feeds. Operational emission event alerts were based on the standard LongPath alert criteria of persistent (low intermittency) emissions above a given site's optimized alert threshold. We limited the analysis to mid-May onward, to remove any impact of initial spin up of sites and alert thresholds. There were 9 alerts per month on average in the data-on period and 31 alerts per month in the data-off period. Put another way, nearly half (46%) of all alerts occurred during the data-off period, despite that period representing less than 23% of the total site-months of measurement. Importantly, the frequency of emission events at any site in the network nearly tripled at the onset of the data-off period; the average time between new emission events (at any site) decreased from 82 hours in the data-on period to only 28 hours in the data-off period.

Interestingly, the decrease in average time between emission events appeared to be driven in part by sites with “repeat offender” emission events. Among all sites with more than one emission event during the monitoring period, the average time between repeat events decreased by 16% (from 40 days to 34 days) from the data-on period to the data off period. Most important, however, was the finding that the probability of recurrence of an emission event at the *same site* within 7 days or less was much higher during the data-off period. During the data-on period, only 8% of recurred emission events happened within 7 days of a previous emission event at the same site, whereas during the data-off period that rate was 39%. This finding, that emission events were roughly 5 times more likely to recur without operator access to data and alerts, suggests a strong dependence of fugitive emission recurrence on access to monitoring data as well as a possible root cause that is intermittent in nature, such that failure to identify the root cause will result in recurrence.

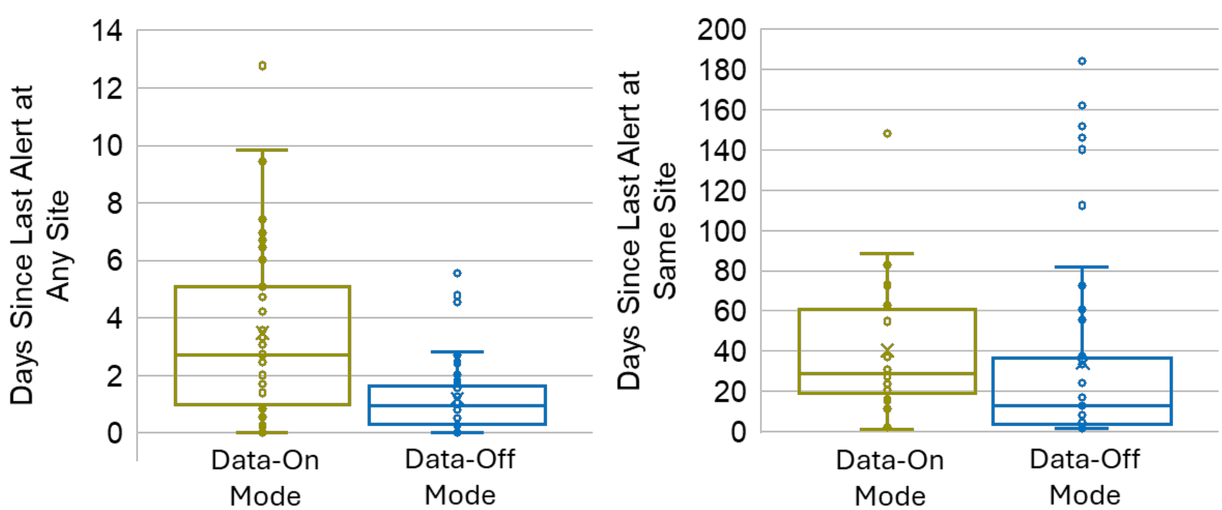

Figure 4. Time between operational emission event alerts, indicative of potential fugitive or other unplanned emissions, in the data-on (yellow) and data-off (blue) modes. Left-hand panel shows days between alerts at any sites in the monitoring network, and right-hand panel shows days between alerts at the same site. X symbols show the mean values.

The availability of CEMM data was associated with lower emissions overall, and without CEMM data, more emission events occurred overall, possibly due to systematic or repeat process failures or malfunctions that otherwise would have been caught with the CEMM system had alarms been activated. This data furthermore suggests that the use of advanced methane monitoring technologies cannot be effective simply as a one-time or periodic "clean-up" of emissions. Overall, the finding that the first 7.5 months of monitoring were followed by 1.5 months of the worst emissions performance of the entire test period suggests that ongoing monitoring may be strongly associated with sustained low emissions.

3.3 Effects of Seasonality on Emission Rate

Varon et al. (in review) show a link between seasonality of methane emissions and monthly average surface temperatures in Midland, Texas, representative of the Permian Basin.[12] Past work by the same lead author found that gas price, new well development, flaring and production fail to explain seasonal variation in emissions.[13] The authors' more recent study suggests that separator temperatures may predict tank flashing, such that lower temperatures correlate with higher emissions. We therefore investigated whether surface temperature through the course of the measurement period was associated with emission rate changes.

The Basin 1 dataset contained 2 full quarters of data: the first (JFM) and fourth (OND). Consistent with Varon et al. (in review), the highest average emission rates occurred in JFM and OND, although they were also the only two quarters with three full months of data. However, in Basin 1, only a small negative correlation was found between daily average emission rate and the average daily temperature from the nearest Automated Surface Observing Station (ASOS) (R^2 = -0.12, p = 0.04), indicating only a weak predictive power of temperature for emissions, despite a large range of monthly average temperatures of 26 C.

The Basin 2 dataset spanned the second (AMJ), third (JAS) and fourth (OND) quarters of one year. Consistent with Varon et al. (in review), the minimum monthly, weekly and daily emission rates were in JAS.[12] The highest monthly emission rate was in OND, and the first and second highest weekly and daily emission rates were in AMJ and OND. Weather station data from the ASOS nearest to the Basin 2 asset showed average daily temperature of 23.9 ± 5.0 C before data turnoff and 10.4 ± 5.8 C after data turnoff. Using the tank flashing emission ratio estimates for liquid hydrocarbon and water storage tanks for separator temperatures from Varon et al. (and Cardoso-Saldaña et al.), the emissions from each tank type could have increased by 20% and 50%, respectively, from the data-on to the data-off period (due to a predicted increase in normalized methane emissions from roughly 0.70 and 0.60 for hydrocarbon and water tanks, respectively, in the data-on period to roughly 0.84 and 0.90, respectively, for hydrocarbon and water tanks in the data-off period due to separator temperature).[12,14] A small but statistically significant relationship was found between higher temperatures and lower emissions (R^2 = -0.31, p >0.01); interestingly, the percent of the data that could be explained by temperature (~31%) was consistent with previous findings that liquid storage tank emissions account for roughly 1/3 of total emissions detected in aerial surveys.[15,16]. Therefore, it is possible that some, but not all, of the 63% increase in emissions from the data-on to the data-off period was explainable by separator temperatures.

The residuals from a linear regression fit of the daily emission rate data to the temperature data showed that emission rates still showed higher tendency for larger, higher-rate events in the data-off period than the data-on period even after correcting for temperature (Figure 5). This suggests that, even regressing for a 100% causation of temperature effects on temporal trends in emissions (which, as described above, is unrealistic), a substantial data-on to data-off effect on emissions persists.

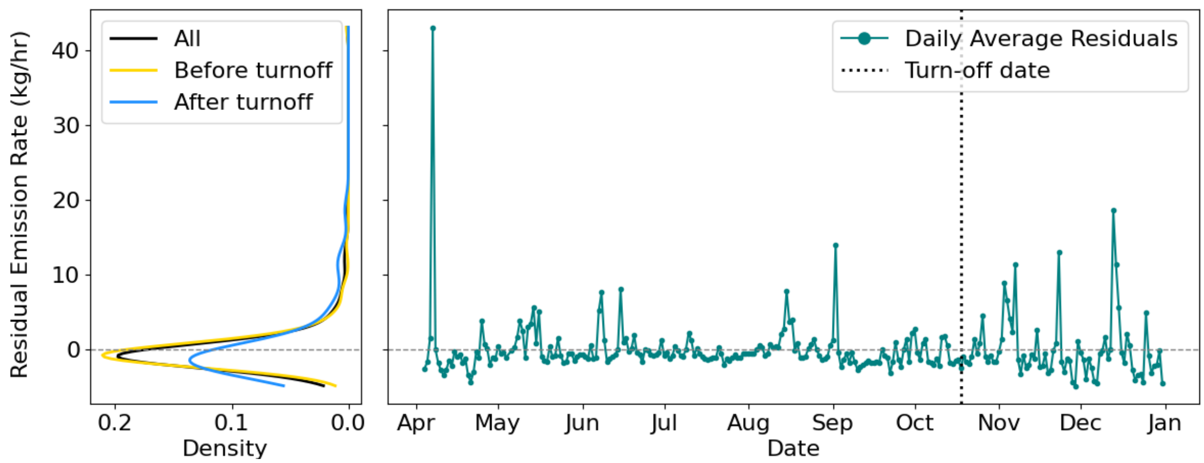

Figure 5. Residuals from a linear regression of daily emission rate to daily average temperature (right-hand panel) with distributions of residuals shown in data-on mode (yellow) and data off mode (blue) on the left-hand pane. The data turn-off date is shown with a vertical dotted line in the right-hand panel.

4.0 Conclusions

This work contributes to the growing body of evidence that measurement and monitoring of emissions at a high frequency and with widespread asset coverage is critical to driving and proving emissions reductions and mitigation success.[3] This work builds on past studies by showing the impact on actual measured emissions of providing oil and gas operators with real-time information about emission rates and emission events (e.g., fugitive emission alerts).

Supporting Information. The following information is available free of charge: Supporting Information (PDF), including trend analysis and site counts across operational data collection.

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Author Contributions

CA contributed writing and data analysis. DC, GR and DY contributed data collection and operator coordination. All authors have given approval to the final version of the manuscript.

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REFERENCES

(1) Masson-Delmotte, V.; Zhai, P.; Pirani, A.; Connors, S. L.; Pean, C.; Berger, S.; Caud, N.; Chen, Y.; Goldfarb, L.; Gomis, M. I.; Huang, M.; Leitzell, K.; Lonnoy, E.; Matthews, J. B. R.; Maycock, T. K.; Waterfield, T.; Yelecki, O.; Yu, R.; Zhou, B. *Climate Change 2021: The Physical Science Basis*; IPCC, 2021.

(2) Saunois, M.; Martinez, A.; Poulter, B.; Zhang, Z.; Raymond, P. A.; Regnier, P.; Canadell, J. G.; Jackson, R. B.; Patra, P. K.; Bousquet, P.; Ciais, P.; Dlugokencky, E. J.; Lan, X.; Allen, G. H.; Bastviken, D.; Beerling, D. J.; Belikov, D. A.; Blake, D. R.; Castaldi, S.; Crippa, M.; Deemer, B. R.; Dennison, F.; Etiope, G.; Gedney, N.; Höglund-Isaksson, L.; Holgerson, M. A.; Hopcroft, P. O.; Hugelius, G.; Ito, A.; Jain, A. K.; Janardanan, R.; Johnson, M. S.; Kleinen, T.; Krummel, P. B.; Lauerwald, R.; Li, T.; Liu, X.; McDonald, K. C.; Melton, J. R.; Mühle, J.; Müller, J.; Murguia-Flores, F.; Niwa, Y.; Noce, S.; Pan, S.; Parker, R. J.; Peng, C.; Ramonet, M.; Riley, W. J.; Rocher-Ros, G.; Rosentreter, J. A.; Sasakawa, M.; Segers, A.; Smith, S. J.; Stanley, E. H.; Thanwerdas, J.; Tian, H.; Tsuruta, A.; Tubiello, F. N.; Weber, T. S.; van der Werf, G. R.; Worthy, D. E. J.; Xi, Y.; Yoshida, Y.; Zhang, W.; Zheng, B.; Zhu, Q.; Zhu, Q.; Zhuang, Q. Global Methane Budget 2000–2020. *Earth Syst. Sci. Data* **2025**, *17* (5), 1873–1958. https://doi.org/10.5194/essd-17-1873-2025.

(3) Hodshire, A.; Duggan, G.; Zimmerle, D.; Santos, A.; McArthur, T.; Bylsma, J.; Alden, C.; Youngquist, D.; White, A.; Rieker, G. Intermittent Emissions from Oil and Gas Operations: Implications for Detection Effectiveness from Periodic Leak Detection Surveys, In Review.

(4) Zimmerle, D.; Vaughn, T.; Bell, C.; Bennett, K.; Deshmukh, P.; Thoma, E. Detection Limits of Optical Gas Imaging for Natural Gas Leak Detection in Realistic Controlled Conditions. *Environ. Sci. Technol.* **2020**, *54* (18), 11506–11514. https://doi.org/10.1021/acs.est.0c01285.

(5) Bell, C.; Ilonze, C.; Duggan, A.; Zimmerle, D. Performance of Continuous Emission Monitoring Solutions under a Single-Blind Controlled Testing Protocol. *Environ. Sci. Technol.* **2023**, *57* (14), 5794–5805. https://doi.org/10.1021/acs.est.2c09235.

(6) Chen, Z.; El Abbadi, S. H.; Sherwin, E. D.; Burdeau, P. M.; Rutherford, J. S.; Chen, Y.; Zhang, Z.; Brandt, A. R. Comparing Continuous Methane Monitoring Technologies for High-Volume Emissions: A Single-Blind Controlled Release Study. *ACS EST Air* **2024**, *1* (8), 871–884. https://doi.org/10.1021/acsestair.4c00015.

(7) MATM-005: LongPath Technologies Alternative Test Method, 2025. https://www.epa.gov/emc/oil-and-gas-alternative-test-methods.

(8) Coburn, S.; Alden, C. B.; Wright, R.; Cossel, K.; Baumann, E.; Truong, G.-W.; Giorgetta, F.; Sweeney, C.; Newbury, N. R.; Prasad, K.; Coddington, I.; Rieker, G. B. Regional Trace-Gas Source Attribution Using a Field-Deployed Dual Frequency Comb Spectrometer. *Optica* **2018**, *5* (4), 320. https://doi.org/10.1364/OPTICA.5.000320.

(9) Rieker, G. B.; Giorgetta, F. R.; Swann, W. C.; Kofler, J.; Zolot, A. M.; Sinclair, L. C.; Baumann, E.; Cromer, C.; Petron, G.; Sweeney, C.; Tans, P. P.; Coddington, I.; Newbury, N. R. Frequency-Comb-Based Remote Sensing of Greenhouse Gases over Kilometer Air Paths. *Optica* **2014**, *1* (5), 290. https://doi.org/10.1364/OPTICA.1.000290.

(10) Alden, C. B.; Coburn, S. C.; Wright, R. J.; Baumann, E.; Cossel, K.; Perez, E.; Hoenig, E.; Prasad, K.; Coddington, I.; Rieker, G. B. Single-Blind Quantification of Natural Gas Leaks from 1 Km Distance Using Frequency Combs. *Environ. Sci. Technol.* **2019**, *53* (5), 2908–2917. https://doi.org/10.1021/acs.est.8b06259.

(11) Alden, C. B.; Wright, R. J.; Coburn, S. C.; Caputi, D.; Wendland, G.; Rybchuk, A.; Conley, S.; Faloona, I.; Rieker, G. B. Temporal Variability of Emissions Revealed by Continuous, Long-Term Monitoring of an Underground Natural Gas Storage Facility. *Environ. Sci. Technol.* **2020**, *54* (22), 14589–14597. https://doi.org/10.1021/acs.est.0c03175.

(12) Varon, D. J.; East, J. D.; Pendergrass, D. C.; Chen, Z.; Sulprizio, M.; Gautam, R.; Barkley, Z. R.; Cardoso-Saldaña, F. J.; Reidy, E. K.; Kamdar, H.; Sherwin, E. D.; Biraud, S. C.; Jervis, D.; Pandey, S.; Worden, J. R.; Bowman, K. W.; Maasakkers, J. D.; Kleinberg, R. L. Seasonality and Declining Intensity of Methane Emissions from the Permian and Nearby US Oil and Gas Basins.

(13) Varon, D. J.; Jacob, D. J.; Hmiel, B.; Gautam, R.; Lyon, D. R.; Omara, M.; Sulprizio, M.; Shen, L.; Pendergrass, D.; Nesser, H.; Qu, Z.; Barkley, Z. R.; Miles, N. L.; Richardson, S. J.; Davis, K. J.; Pandey, S.; Lu, X.; Lorente, A.; Borsdorff, T.; Maasakkers, J. D.; Aben, I. Continuous Weekly Monitoring of Methane Emissions from the Permian Basin by Inversion of TROPOMI Satellite Observations. *Atmos. Chem. Phys.* **2023**, *23* (13), 7503–7520. https://doi.org/10.5194/acp-23-7503-2023.

(14) Cardoso-Saldaña, F. J.; Pierce, K.; Chen, Q.; Kimura, Y.; Allen, D. T. A Searchable Database for Prediction of Emission Compositions from Upstream Oil and Gas Sources. *Environ. Sci. Technol.* **2021**, *55* (5), 3210–3218. https://doi.org/10.1021/acs.est.0c05925.

(15) Cusworth, D. H.; Duren, R. M.; Thorpe, A. K.; Olson-Duvall, W.; Heckler, J.; Chapman, J. W.; Eastwood, M. L.; Helmlinger, M. C.; Green, R. O.; Asner, G. P.; Dennison, P. E.; Miller, C. E. Intermittency of Large Methane Emitters in the Permian Basin. *Environ. Sci. Technol. Lett.* **2021**, *8* (7), 567–573. https://doi.org/10.1021/acs.estlett.1c00173.

(16) Sherwin, E. D.; Rutherford, J. S.; Zhang, Z.; Chen, Y.; Wetherley, E. B.; Yakovlev, P. V.; Berman, E. S. F.; Jones, B. B.; Cusworth, D. H.; Thorpe, A. K.; Ayasse, A. K.; Duren, R. M.; Brandt, A. R. US Oil and Gas System Emissions from Nearly One Million Aerial Site Measurements. *Nature* **2024**, *627* (8003), 328–334. https://doi.org/10.1038/s41586-024-07117-5.

Supporting Information

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Figure S1

1. Weekly and Monthly Trends in Emissions in Basin 1, with Site Counts

The trends in emission rates are calculated using data from all measured sites and at the mid-point of each week or month. The monthly and weekly average data are plotted at the start of the week or month.

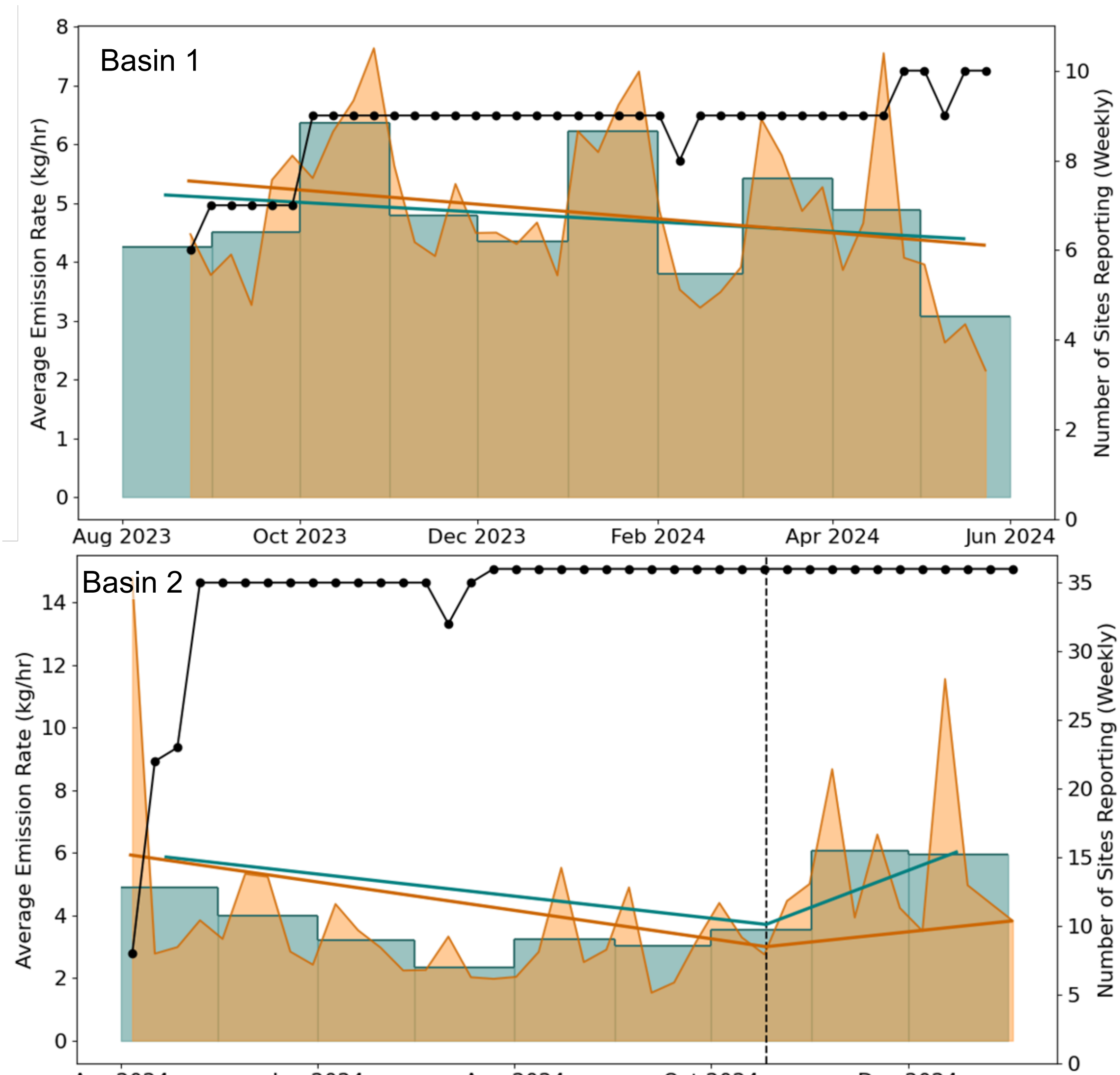

Figure S1. Monthly (filled teal step-wise line) and weekly (filled orange line) average emission rates across all monitored sites. The solid teal and orange lines show trends fitted to the data.

Panel a) shows Basin 1. Panel b) shows Basin 2 and a vertical line marks the time before and after data-off. The number of sites reporting data each week is shown on the right-hand axis with a black line and black circular markers. The linear trends are plotted at the mid-point of the week and month and are forced to visually align with the data turnoff date, whereas the monthly step-wise line and weekly filled line are plotted at the beginning of the month to clearly show visually what month the data represent; that is why the fits do not overlap the data.