UCLA School of Law Emmett Institute on Climate Change & the Environment

Advancing Methane Regulation: Implications of New Monitoring Technologies
Discussion Paper
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Executive Summary

Rapid advances in remote sensing of methane, from satellites and other platforms, are enabling increasingly complete and accurate estimation of methane emissions worldwide, at scales from single point sources to continents. At the same time, cutting methane emissions has become a top priority for near-term greenhouse-gas mitigation, due to methane's high global warming potential and short atmospheric lifetime, and the availability of low-cost control options for many emissions sources.

Advances in methane remote sensing have already enabled identification of large emissions point sources, many not previously quantified or known; increasingly refined description of patterns of emissions variability across time, location, and source activity; near-real-time provision of emissions information to sources or relevant authorities to facilitate their prompt response; development of observation-informed jurisdictional emissions inventories, which in many cases are revealing large prior under-estimates; and beginning efforts, still tentative and *ad hoc*, to incorporate new observations into enforcement of current methane regulations or other controls.

Over the next few years, ongoing advances in methane remote sensing may converge toward a consistent, integrated, widely available, finely detailed picture of emissions at multiple scales from point source to globe. The implications of these new data for methane regulation and control may be transformative, including, for example: enabling effective controls in additional, now mostly uncontrolled sectors; enabling new controls operating through various commercial and policy channels at diverse spatial and jurisdictional scales; substantial strengthening of technical, assessment, and regulatory capacity in under-resourced jurisdictions; and empowerment of communities suffering serious environmental harms, through direct provision of information. Yet these potentially profound implications are thus far little explored. So too are the substantial challenges and limitations the new data may present to use in authoritative regulations and policies, including potential barriers to accessibility and trust in data from third-party or foreign sources; international tensions related to cross-border provision of information

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about higher-than-recognized emissions; and evidentiary and procedural requirements for emissions control systems that deploy significant reward or penalties. Both the opportunities and challenges are likely to vary widely among jurisdictions, due to diversity of emissions-source industry structure, legal and political context, and technical, legal, and administrative capacity.

The Emmett Institute on Climate Change and the Environment at the UCLA School of Law has launched the Advancing Methane Regulation Project to advance understanding and practice relevant to these coming opportunities and challenges by helping to bridge the gap between rapidly advancing observation capabilities and methane law and policy-making. This Discussion Paper summarizes and builds on discussions at an October 2023 workshop, which convened experts and law and policy-makers to explore the implications and limitations of the new observational advances for methane control.

I. Introduction to Global Methane Regulations

Reducing methane emissions is a high priority for greenhouse gas mitigation. Since 2021, 150 jurisdictions have signed the Global Methane Pledge, committing to cut their collective emissions 30 percent below 2020 levels by 2030.[2] Many jurisdictions have joined additional cross-border methane initiatives, including the Subnational Methane Action Initiative[3] and the Joint Declaration from Energy Importers and Exporters on Reducing Greenhouse Gas Emissions from Fossil Fuels.[4] In addition, many national and subnational jurisdictions have separately adopted strategies or regulations to cut methane.

There are several reasons for the current focus on cutting methane. Methane's short atmospheric life and high global warming potential make methane cuts high-value in reducing near-term climate change, indeed necessary to meet the Paris temperature targets.[5] Many methane emissions, particularly in the oil and gas sector, can be avoided at low or negative net cost, so firms have incentives to cut emissions and proposed policy controls do not face strong industry opposition.[6] Finally, advances in methane remote sensing—measuring methane from a distance by observing its effects on transmitted or scattered radiation—are opening many new regulatory, enforcement, and informational possibilities. Several jurisdictions are starting to use methane remote sensing from aerial, satellite, and ground-based platforms and more are planning to do so soon.

The trajectory and potential limitations of these advances are still emerging. Yet they are likely to have profound implications for methane control efforts, whether pursued through managerial, market, informational, regulatory, or other legal and policy channels. Thus far, however,

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2 Global Methane Pledge, Climate & Clean Air Coalition Secretariat (Nov. 17, 2023).

3 Press Release, Office of Governor Gavin Newsom, California Enlists Governments Around the World to Fight Methane Pollution (Sept. 20, 2023).

4 U.S. Dept. of State, Joint Declaration from Energy Importers and Exporters on Reducing Greenhouse Gas Emissions from Fossil Fuels.

5 *See*, *e.g.*, E. G. Nisbet et al., *Methane Mitigation: Methods to Reduce Emissions, On the Path to the Paris Agreement*, 58 REV GEOPHYS (Jan. 14, 2020).

6 Int'l Energy Agency, Marginal Abatement Cost Curve for Oil and Gas Methane Emissions by Mitigation Measure (last updated Feb. 21, 2023).

awareness of these advances and their significance among officials and legislators is limited, even in many well-resourced jurisdictions. Efforts to put the new methane data to practical use have mainly taken two paths: direct provision of information to emitters; and efforts to update and revise national or sub-national emissions inventories. In the case of the first efforts, emitters' receptivity to the new information has been uneven. And the second have faced significant challenges, due to potential incompatibilities with current inventory practices and guidelines, and the expectation of political embarrassment and controversy when the new data suggest actual emissions are higher, perhaps much higher, than presently believed.

Beyond those two types of effort, initiatives to incorporate new monitoring data into methane control initiatives have been tentative and *ad hoc*. A few jurisdictions are experimenting with using the new data to inform enforcement efforts, or are supporting research and application efforts to validate the new data, integrate them with other sources, and disseminate them. But the profound implications of the new data—which under some scenarios might soon provide a consistent, integrated, widely available, finely detailed picture of methane emissions at multiple scales from point source to globe—remain largely unexplored. So too do the significant challenges and limitations the new data may present to use in authoritative regulations and policies, with both the opportunities and challenges likely to vary widely among jurisdictions.

II. UCLA Project and Workshop

The Emmett Institute on Climate Change and the Environment of UCLA's School of Law has recently launched the Advancing Methane Regulation Project ("the Project"). The Project aims to address these coming opportunities and challenges, helping to bridge the gap between policy-making and rapidly advancing methane detection technologies. More specifically, the Project aims to inform law and policymakers in diverse jurisdictions about advances in remote sensing technology and their significance, and to work collaboratively with them to identify and develop new approaches to methane control that effectively take advantage of new observational capabilities and address the associated challenges and limitations, starting with developing a few illustrative case studies and identifying best practices. In October 2023, the Emmett Institute convened technical and policy experts, regulators, and legislators for a two-day workshop that explored current methane control strategies and coming opportunities and challenges.[7] A briefing paper, published with this discussion paper, reviews current regulatory approaches for methane at the US state and federal level and in multiple other jurisdictions.[8]

As a follow-up to the workshop, this discussion paper reviews: (1) the state of methane observation capabilities, current and projected in the next few years; (2) current efforts to integrate remote methane monitoring into regulatory regimes; (3) emerging opportunities to use remote sensed data to improve methane regulation and control; and (4) current and anticipated challenges to the effective legal and regulatory use of remote methane observations.

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7 UCLA School of Law, Advancing Methane Regulation (last visited Nov. 21, 2023).

8 Gabriel Greif, The State of Methane Regulation: A Global Survey, Emmett Institute on Climate Change & the Environment, UCLA Emmett Institute on Climate Change and the Environment (Oct. 26, 2023).

III. Remote Observation of Methane: Status, Progress, and Challenges

Rapid advances in remote sensing, including new instruments, platforms, and data integration systems, are allowing methane observations at scales from single point sources to continents. These advances present important new opportunities to observe and control methane, and novel limitations that will influence their use in specific control settings, with the details of both opportunities and limits still emerging.

Formerly, methane estimation, reporting, and control used little or no direct observation of emissions. Jurisdictional emissions inventories, as required of national parties to the FCCC based on IPCC guidelines, have used "bottom-up" methods, in which reported activity levels (measures of production output, specified equipment, etc.) are multiplied by standard emissions factors. Of the vast number of emissions factors required, many reflect inaccurate or outdated studies and none completely accounts for variability of emissions, including super-emitter events.[9] Regulation of emissions sources has mostly involved facility-specific technology requirements, often including requirements for leak detection and repair (LDAR) or monitoring, reporting, and verification (MRV) at specific components. Operators sometimes use optical gas imaging (OGI) cameras, handheld or stationary infrared imaging devices, to observe gas concentrations at component or site scale, but these are often viewed as more costly and difficult to operate than alternative LDAR approaches.[10]

Over the last ten years, governments, facility operators, and NGOs have deployed multiple airborne and satellite instruments for remote observation and measurement of methane. Like OGI cameras, these instruments observe infrared light at frequencies that interact strongly with methane molecules to estimate total methane along the instrument's line of sight from an aircraft-borne instrument to its target or a satellite-borne instrument to the ground. Multiple nearby observations can be used to construct detailed images of emissions plumes. Estimates of methane emissions are calculated from these observations of total amounts, often requiring additional information about wind or other data and assumptions.

These new remote sensing technologies expand methane observation capabilities in multiple ways. Their wide areal coverage—potentially global for satellite instruments, depending on specific choices of instrument design and satellite orbit—lets them estimate methane over extended areas, capturing many more emissions sources than direct on-site measurements. They can thus evaluate and supplement bottom-up emissions inventories with "top-down" estimates, at scales from major oil and gas basins to continents.[11] Their capacity for frequent observations can allow them to distinguish intermittent emissions sources, such as maintenance events, from

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9 Penwadee Cheewaphongphan et al., *Exploring Gaps Between Bottom-Up and Top-Down Emissions Estimates Based on Uncertainties in Multiple Emission Inventories*, 11 J. Sustainability 2054 (Apr. 9, 2019).

10 Ángel E. Esparza et al., *Analysis of a Tiered top-Down Approach Using Satellite and Aircraft Platforms to Monitor Oil and as Facilities in the Permian Basin*, 178 Renewable & Sustainable Energy Revs. (May 2023).

11 *See* Int'l Energy Agency, Understanding Methane Emissions, https://www.iea.org/reports/global-methane-tracker-2023/understanding-methane-emissions; Penwadee Cheewaphongphan et al., *Exploring Gaps Between Bottom-Up and Top-Down Emissions Estimates Based on Uncertainties in Multiple Emission Inventories*, 11 J. Sustainability 2054 (Apr. 9, 2019), https://www.mdpi.com/2071-1050/11/7/2054.

persistent leaks. Moreover, the high spatial resolution of airborne and some satellite instruments can let them detect and precisely locate high-emitting point sources, including sources that are hard to observe with OGI or other on-site methods for reasons of accessibility, safety, or cost.[12] A few such high-emissions sources, or "super emitters," can account for 20 to 60 percent of total emissions in some regions and sectors, presenting high-value, low-cost opportunities for mitigation.[13]

Different instruments aim to optimize observations at different spatial scales via design decisions including their total coverage and smallest observing unit (pixel size). Satellite instruments are typically grouped into two types on this basis. Area flux mappers, such as the European Space Agency's Sentinel-5P/TROPOMI mission, aim to quantify emissions at regional to global scale, with pixel sizes from 1 to 10 km. Point-source imagers—such as NASA's EMIT mission, the commercial GHGSat constellation, and the non-governmental Carbon Mapper constellation—aim to locate and quantify emissions at facility scale by imaging individual plumes, with pixel sizes less than 60 m.[14] The Environmental Defense Fund's (EDF) MethaneSAT instrument falls between these groups: while mainly designed as an area flux mapper, its pixel size of a few hundred meters will also enable it to detect some large point sources.[15]

These new observing capabilities have various limitations that will influence and delimit their usability in policy and legal settings. In addition to design-based limits of spatial and spectral resolution, coverage, and observation frequency, satellite instruments require clear weather and sufficiently high sun angle, and do not observe reliably over water, ice, or snow. All instruments also have detection thresholds—minimum emissions rates below which they cannot detect emissions. Currently claimed detection thresholds—as low as 50 kg per hour for satellite instruments and one kg per hour for airborne instruments—reflect ideal observing conditions in controlled conditions and do not account for probability of detection (the likelihood that a leak above the detection threshold will be spotted), so practical limits to reliable detection are likely substantially higher.[16] Emissions rates below these thresholds require other measurement methods, typically ground-based sensors.

Some limits can be mitigated by using other, complementary sources. Airborne instruments, for example, lack the low cost and global coverage advantages of satellites, but can conduct repeated observations on specified flight paths at extremely fine spatial resolution, with pixels as small as

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12 Esparza et al., *supra* note 10; Chandler E. Kemp & Arvind P. Ravikumar, *New Technologies Can Cost Effectively Reduce Oil and Gas Methane Emissions, but Policies Will Require Careful Design to Establish Mitigation Equivalence*, Envtl. Sci. & Tech. (May 20, 2021).

13 Daniel H. Cusworth et al., Strong Methane Point Sources Contribute a Disproportionate Fraction of Total Emissions Across Multiple Basins in the United States, 119 Proceedings of the National Academy of Sciences (Sept. 13, 2022).

14 Daniel J. Jacob et al., Quantifying Methane Emissions From the Global Scale Down to Point Sources Using Satellite Observations of Atmospheric Methane, 22 Atmos. Chem. & Phys. 9618. 9618-19 (Apr. 2022).

15 *See* Earth Observation Portal, MethaneSAT: Quick Facts (May 4, 2021).

16 Javier Gorroño et al., *Understanding the Potential of Sentinel-2 For Monitoring Methane Point Emissions*, 16 Atmospheric Measuring Techniques 89 (Jan. 10, 2023); Bridger Photonics, What is Methane Detection Sensitivity? (last visited Nov. 27, 2023).

60 cm.[17] Aircraft can also use active measurement methods such as light detection and ranging (LiDAR), which avoid some limits of current satellite instruments by using an active laser light source rather than relying on reflected sunlight, but are presently impractical for satellite use.

Integrated use of multiple complementary methods can provide rich, multi-scale pictures of emissions over large regions that are not possible from any single source.[18] For example, EDF's Permian Methane Analysis Project combined satellite, aircraft, and ground-based observations over the Permian Basin, an 86,000 square mile oil field in the Southwest United States, to provide near real-time emissions monitoring, characterize large emissions events, and estimate emissions intensity of oil and gas operators in the Basin. The project revealed emissions up to triple EPA bottom-up estimates, mainly from large, previously unreported emissions events.[19] In another example, a series of aerial surveys by the California Air Resources Board (CARB) and Carbon Mapper found multiple super-emitters, whose facility operators were unaware of nearly half the reported emissions and voluntary repaired them.[20]

IV. Current Efforts to Integrate Remote Methane Monitoring into Regulatory Regimes

While substantial advances in the coverage, detail, and availability of remote sensed methane data are projected soon, there are many opportunities for national and subnational governments to use these data even with current technology and regulatory frameworks. This section discusses several such opportunities, including use of remote sensing data in regulation and enforcement, and to improve emissions inventories.

a. Incorporating remote sensing data in regulation and enforcement.

Until recently, regulators have been reluctant to formally incorporate remote sensing data in regulation or enforcement. Remote sensing operators, including the US National Aeronautics and Space Administration (NASA), have sometimes notified operators or regulatory authorities when satellite or aircraft instruments detect large methane plumes, but these activities have been *ad hoc* and reactive, not part of any formal mandate.[21] Regulators are now increasingly considering ways to incorporate remote methane observations in regulation, reporting, or enforcement systems, often in conjunction with *in situ* observations.

For instance, the California Air Resources Board (CARB) recently approved regulations that will allow satellite operators to submit data on observed methane leaks. Satellite operators must be pre-approved and meet specified technical standards, including spatial resolution and timely data

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[17] Daniel H. Cusworth et al., Intermittency of Large Methane Emitters in the Permian Basin, 8 Envtl. Sci. Tech. 567 (June 2, 2021).

[18] Riley Duren, Testimony, House Science, Space & Technology Committee (May 18, 2021).

[19] *See, e.g.*, Envtl. Def. Fund, PermianMAP Final Report 8 (Nov. 2022).

[20] Report, Cal. Air Res. Bd., Summary Report of the 2020 and 2021 Airborne Methane Plume Mapping Studies (May 2023).

[21] *See, e.g.*, Nat'l Aeronautics and Space Admin. PIA22467 (June 1, 2018) (describing the identification and reporting of a previously-unreported natural gas leak in Chino Hills, California).

availability.[22] Based on these data, CARB will notify oil and gas operators, who have five days to inspect their facility followed by a repair deadline that depends on the leakage rate estimated from the initial plume observation.[23] To implement this rule, CARB has allocated funds to support satellites that will "enforce and further inform" the state's methane regulations.[24] US EPA has proposed similar regulations under its Super-Emitter Response Program (SERP)—part of a larger proposed methane rule—which, upon final adoption, will allow pre-approved remote sensing operators to notify regulated entities of large methane leaks directly.[25]

A 2023 rule by the Colorado Air Pollution Control Division requires oil and gas producers to conduct and report on-site methane monitoring, verified by accredited third parties, to ensure they conform with the state's greenhouse gas intensity standards.[26] The intensity standards, limits on total greenhouse-gas emissions of both facilities and companies per unit of oil and gas production, were enacted in a prior 2021 regulation. While the 2023 rule requires operators to report direct *in situ* measurements, the state will also conduct its own measurements using satellite, aircraft, and ground-based instruments.[27] If a facility fails to report using direct observation technologies, it must report its methane emissions intensity using annually-updated default emissions factors, supplemented by the State's own remote sensed data. The intensity verification protocol takes an iterative approach, encouraging the agency to periodically revise its approved technologies and standards as data availability improves. In contrast to the US EPA and California rules—which apply to individual facilities—the Colorado rule requires operators to demonstrate and verify compliance both for new facilities and across a company's complete portfolio of oil and gas production facilities.[28]

The 2023 rule builds on and extends an innovative feature of the 2021 rule. Because the prior rule controls total emissions intensity across facilities and firms, it gives operators more compliance flexibility than component-specific regulations. It thus creates incentives to cut emissions at all sources, including those the State could not regulate directly due to federal preemption. Similarly, because the 2023 rule requires observations to verify the facility and firm-wide emissions inventories used in intensity calculations, it effectively requires observation and reporting from components where direct emission observations would not otherwise be required. To provide still more flexibility, promote industry cooperation, and encourage monitoring innovation, the 2023 rule also lets operators propose their own alternative monitoring plans, subject to State approval, using various mixes of parametric data and monitoring technology.[29]

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22 14 Cal. Code Regs. § 95669.1 (as proposed, June 28, 2023). "Remote monitoring data," per the Proposed Amendments, only includes remote sensing data obtained from satellites. *Id.* § 95667.

23 *Id.* § 95669(h).

24 State of California, Cal. Air Res. Bd., Budget Change Proposal DF-46 (May 12, 2022).

25 US Envt'l Protection Agency, Determination of Volatile Organic Compound and Greenhouse Gas leaks Using Optical Gas Imaging, Subpart W Appendix K (Nov. 2022).

26 Colorado Dept. Pub. Health, Colorado Adopts First-Of-Its-Kind Measures To Verify Greenhouse Gas Emissions From Certain Oil and Gas Sites (July 20, 2023).

27 Mark Jaffe, *Colorado Is First in the US to Make Rules Tying Pollution Reduction to Oil and Gas Production*, Colorado Sun (July 21, 2023).

28 Colorado Air Pollution Control Division, Reg. 7, Part C, § VIII.G (July 21, 2023).

29 *Id.* § VIII.F.3.a.1.

In their innovative use of remote sensing observations, these rules illustrate novel ways to identify and reduce emissions that would otherwise be difficult to detect, and to reduce reliance on industry self-reporting, which regularly under-estimates emissions.[30] They may thus offer guidance to other jurisdictions, particularly regarding: (1) formalizing processes for accrediting and using third-party remote sensing data, either to enforce existing regulations or directly notify operators of emissions events; (2) leveraging aggregate emissions intensity requirements at firm or facility level to create incentives for accurate and efficient monitoring; and (3) assisting operators in detecting and controlling emissions, including leaks, by using public funds to support remote sensing observations as a public good.

Jurisdictions must consider their own legal context and constraints in attempting to adopt these innovations. For example, the US EPA's SERP proposal has faced legal questions about possible impermissible deputizing of third-party remote sensing operators because, as proposed, it would allow these operators to trigger leak detection and repair requirements by directly informing oil and gas operators of leaks without informing enforcement authorities at EPA.[31] When allowed, however, delegating specified authority to properly vetted and approved third parties could improve enforcement speed and effectiveness, which would be especially important for large leak events.[32]

The rules discussed above apply only to the oil and gas sector, which represents only one third of global anthropogenic methane emissions.[33] This matches the broad pattern of methane control across jurisdictions, where oil and gas sources are regulated while other sectors are addressed through voluntary or incentive-based programs.[34] Remote sensing has significant potential to also aid regulation and enforcement in other sectors, particularly large point sources from waste, coal, and agriculture. CARB, for instance, is considering incorporating methane detection into its landfill regulations, although it has not yet released a concrete proposal.[35]

b. Using remote sensing to improve emissions inventories.

Remote sensing can improve the accuracy of jurisdictional emissions inventories, principally by incorporating observed leaks or other uncounted emissions and by correcting emissions factors. Most current inventory methodologies rely solely on bottom-up estimates, based on activity levels (e.g., production, throughput, or equipment) multiplied by emissions factors that are in many cases inaccurate and do not adequately reflect variation in emissions.[36] Although direct measurements are allowed by the IPCC inventory guidelines, which are used for emissions reporting under the UN Framework Convention on Climate Change (FCCC), bottom-up remains

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30 Suzanne Schadel et al., *Oil and Gas Companies Are Missing Significant Methane Emissions. Here's How to Fix That*, Rocky Mountain Institute (Oct. 19, 2023).

31 Jean Chemnick, *EPA's Risky Methane Gambit: Let Outsiders Look for Leaks*, E&E News (Mar. 1, 2023).

32 Damian Carrington, *1,000 Super-Emitting Methane Leaks Risk Triggering Climate Tipping Points*, The Guardian (Mar. 6, 2023) (cataloging methane leaks reaching up to 434 tonnes per hour).

33 Int'l Energy Agency, Global Methane Tracker 2023 (Feb. 2023).

34 Maria Olczak, Andris Piebalgs, & Paul Balcombe, *A Global Review of Methane Policies Reveals That Only 13% of Emissions Are Covered With Unclear Effectiveness*, 6 One Earth R. 519 (May 2023).

35 Cal. Air Res. Bd., Preliminary Concepts for Potential Improvements to Landfill Methane Regulation 11 (May 18, 2023).

36 Schadel et al., *supra* note 30.

the recommended approach, leading to systematic underreporting of emissions.[37] Canada, for example, estimates that its bottom-up inventory for the oil and gas sector understates methane emissions by 25 to 90 percent.[38] Satellite or other remote sensing data can supplement and improve inventories by incorporating omitted sources, correcting emissions factors, and providing a stronger understanding of temporal variation of emissions, both daily and seasonal.[39]

Remote sensing cannot yet give a reliable and complete picture of regional emissions for various reasons. These include the existence of emissions sources that are intermittent or spatially diffuse, or limits to remote observation related to weather, surface conditions, and sun angle. There is growing interest, however, in hybrid estimates that combine multi-pass aerial measurements with bottom-up measurement of sources that are challenging or costly to measure directly. One recent such hybrid inventory of the oil and gas sector in British Columbia, Canada, estimated emissions 70 percent higher than the official inventory.[40] Canada is currently working with university researchers and satellite operators to incorporate direct measurements more broadly into official inventories.[41]

While the need to integrate remote sensed with *in situ* and bottom-up data for inventories will continue, projected advances in remote data will provide additional opportunities to improve cross-jurisdictional emissions transparency, identify additional opportunities to cut emissions at low or negative cost, and help jurisdictions tailor their reduction efforts.[42] As these advances improve inventories, however, jurisdictions will need to prepare for the policy and political challenges of sudden increases in reported emissions. Because the needed adjustment of policies and trajectories may require significant time and expense, incorporating the new data quickly would provide more lead-time for the required adjustments. In addition, immediate steps to clarify uncertainty in current inventories could help prepare public and stakeholders for the anticipated bad news.[43] Canada has already taken the significant step of explicitly acknowledging the underestimates in its national methane strategy.[44]

V. Emerging Opportunities to Use Remote Sensed Data to Improve Methane Control

As remote sensing tools expand and improve, policymakers will face opportunities to use that data in new ways, both to enhance existing methane control regimes and to design novel

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37 Intergovernmental Panel on Climate Change, 2019 Refinement To the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy. in (eds. Calvo Buendia, E. et al.) 200 (2019).

38 Environment & Climate Change Canada, Faster and Further: Canada's Methane Strategy 11 (Sept. 2022).

39 Jonathan D. Haskett, Advances in Satellite Methane Measurement: Implications for Fossil Fuel Industry Emissions Detection and Climate Policy, Congressional Research Service (Apr. 1, 2022).

40 Matthew R. Johnson et al., *Creating measurement-based oil and gas sector methane inventories using source-resolved aerial surveys*, Nature 5 (Apr. 25, 2023).

41 Marc D'lorio, *Creating Measurement-Based Oil and Gas Sector Methane Inventories Using Source-Resolved Aerial Surveys*, Industrial Decarbonization Network (July 13, 2023).

42 Envtl. Def. Fund, Comments to US EPA, Docket No. EPA-HQ-OAR-2023-0234 17-18 (Oct. 2, 2023).

43 Environmental Defense Fund, Submission to the Global Stocktake: Benefits of Measurement-Based Methane Estimates and Timely Emissions Reductions for Reaching the Long-Term Global Goal on Temperature 4-5 (Aug. 3, 2022).

44 Environment & Climate Change Canada, Faster and Further: Canada's Methane Strategy 11 (Sept. 2022).

applications. These opportunities could enable effective controls in additional, now mostly uncontrolled sectors; enable new controls operating at diverse spatial and jurisdictional scales; strengthen technical, assessment, and regulatory capacity in under-resourced jurisdictions; and empower communities suffering serious environmental harms, through direct provision of information.

This Section discusses four medium-term opportunities to use remote observation to enhance methane controls: (1) improving regulation in sectors other than oil and gas; (2) supporting cross-border methane regulation and pricing; (3) facilitating inter-jurisdictional exchange of methane data, particularly for use in developing countries; and (4) providing emissions information and related technical support to environmental justice communities. Each arena poses its own set of challenges.

a. Expanding application of remote sensing technology and methane regulation in sectors other than oil and gas.

Many regulatory uses of remote-sensed methane data have, so far, applied only to the oil and gas sector. That sector, however, represents only one third of global anthropogenic methane emissions.[45] Methane emissions from other sectors are generally more weakly characterized, and are controlled largely through voluntary or incentive-based programs.[46]

Remote sensing has significant potential to aid regulation and enforcement in other sectors. The degree of this potential varies sector to sector, with the greatest difficult in sectors with the most diffuse and smallest sources. The potential is highest for controlling point sources in the waste, coal, and agricultural sectors.

Some jurisdictions have already begun treating large and medium-sized non-oil and gas emission sources—such as open-air landfills, manure lagoons, and coal mines—as ones whose emissions can be channelized, captured, and used. Regulators have sought to control methane from these sources through incentive programs promoting technologies such as anaerobic digesters and coal mine gas collection systems.[47] These methane collection systems—and associated gathering and transmission pipelines—operate as point sources, rather than as hard-to-detect diffuse sources. They therefore present opportunities for familiar forms of regulation applied to oil and gas facilities, such as LDAR requirements. Remote sensing tools will increasingly be able to help enforce such requirements. Policy-makers have begun to be recognize this potential: Several regulatory agencies, including CARB, are currently considering adopting policies incorporating remote sensing into the direct regulation of landfills or dairies.[48]

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45 Int'l Energy Agency, Global Methane Tracker 2023 (Feb. 2023), https://www.iea.org/reports/global-methane-tracker-2023.

46 Maria Olczak, Andris Piebalgs, & Paul Balcombe, *A Global Review of Methane Policies Reveals That Only 13% of Emissions Are Covered With Unclear Effectiveness*, 6 One Earth R. 519 (May 2023).

47 Greif, *supra* note 8, at 15-17.

48 Cal. Air Res. Bd., Preliminary Concepts for Potential Improvements to Landfill Methane Regulation 11 (May 18, 2023).

The larger challenge and opportunity will be to develop ways for new observation capabilities to facilitate effective control of more spatially diffuse sources, either multiple smaller point-sources or non-point sources. This is a key area where further research and analysis is needed. Although remote sensing technology is less adept at locating and recording diffuse and small emissions sources from these sectors—such as enteric emissions from livestock—remote sensing technology, particularly area flux mappers, are emerging as valuable tools for understanding aggregate emissions from such sources. For instance, the nonprofit coalition Climate TRACE has used satellite remote sensing to map enteric and manure methane emissions from cattle feedlots throughout Texas and California, as well as from landfills.[49] Emissions data from these diffuse operations could help to inform national emissions inventories and refine emissions factors, particularly under varied conditions such as surface temperature. Moreover, quantification of methane emissions may help verify the efficacy of methane abatement practices adopted across large distributed sources, such as feed additives in cattle herds.

A promising path forward to addressing small and very diffuse sources might allow for the use of remote sensing observations through some combination of:

- Attributing responsibility for diffuse emissions observed at larger spatial scales. Some satellites will be very good at providing aggregate emissions estimates from multiple diffuse sources across a larger geographic range. If responsibility for such diffuse emissions can be attributed to a single responsible party—for example, to one firm that owns or manages all the cows over a ten square kilometer area—then such data may be useful and actionable;
- Identifying technical or managerial intervention strategies that can reduce emissions over large areas (e.g., livestock feed additives), and then employing remote sensing tools to track and verify aggregate resulting emission reductions from a well-characterized baseline; and
- Designing policy instruments that distribute effective incentives over multiple actors, using remote sensed observations as compliance validation. Several forms of market-based policies could provide a model for these instruments, such as California's Low Carbon Fuel Standard (LCFS), which aims to promote the collection and use of methane from anaerobic digestion.[50] The LCFS or similarly designed policies could likewise provide incentives to cut emissions over regions of cattle operations or rice cultivation. Regulators' ability to reliably observe changes in emissions over that spatial scale, as may soon be possible through remote sensing, would make such policy instruments feasible.

b. Using remote sensing to support cross-border methane regulation and pricing.

Scholars and others are increasingly proposing cross-jurisdictional actions on methane emissions reporting and control, effected through international trade.[51] Such regimes are usually adopted by

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49 Phil McKenna, Georgina Gustin, & Peter Aldhouse, *A Texas Dairy Ranks Among the State's Biggest Methane Emitters. But Don't Ask the EPA or the State About It.*, InsideClimateNews (Aug. 18, 2023).

50 *See* Cal. Code Regs., tit. 17, § 95488.9(f) (describing award of credits to producers of biomethane collected by dairy digesters).

51 *See, e.g.,* Kimberly Clausing, Luis Garicano, & Catherine Wolfram, Policy Brief, *How An International Agreement On Methane Emissions Can Pave the Way for Enhanced Global Cooperation on Climate Change*, Peterson Institute for International Economics (June 2023).

importing jurisdictions and condition market access on required actions to be taken, or carbon taxes to be paid, by exporting jurisdictions to reduce or account for differences in embedded greenhouse gases in imported goods.

They attract substantial controversy and objection for three reasons: they apply the importers' domestic laws and regulations extraterritorially; they are sometimes protectionist, designed and implemented to protect the importing jurisdiction's industries from foreign competition; and they often make little accommodation for the development status of the exporting states on which they are imposed.

Advances in remote sensing, particularly from satellites, may be tightly implicated in these actions and the associated controversies, because they can—subject to certain limitations—provide consistent emissions estimates worldwide and across borders, potentially reducing haggling or gaming over the carbon footprint of imported goods subject to the regulation. The universality and uniformity of remote sensing data may thus help mitigate some controversies associated with cross-jurisdictional actions, even as the origin of such data in non-accountable foreign observers may also exacerbate controversy.

The European Union (EU) is the leading recent proponent of such cross-border emissions measures, for methane and more broadly.[52] Its proposed methane legislation, which very recently achieved legislative consensus to move forward to adoption, leverages the EU's power as a major natural-gas importer to require exporting jurisdictions to submit source-level monitoring, reporting, and verification (MRV) information and to observe specified leak detection and repair protocols.[53]

Notably, the EU rule has begun to sketch ways to employ remote sensing technology to improve operation and enforcement.[54] The latest legislative agreement contemplates the establishment of a global methane monitoring tool and rapid alert mechanism by 2027, which would rely on methane satellite data. In addition, the rule's MRV requirements would eventually require some use of site-level methane measurements, typically achieved using remote sensing technology mounted on a mobile platform or continuous *in situ* direct observation.[55] But implementation guidelines have not yet been worked out for either of these provisions.

So far, the EU's cross-border proposed methane legislation applies only to the importation of natural gas. In the future, the EU might expand this program to include other imported goods; or might incorporate methane emissions into its broader Carbon Border Adjustment Mechanism (CBAM), which launched recently but which does not currently account for embedded methane

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52 Tim Boersma & Robert Kleinberg, *Prospects for EU Extraterritorial Reduction of Methane Emissions From Its Natural Gas Supply*, Columbia Center of Global Energy Policy (June 15, 2023).

53 *Id.* European Council, Climate Action: Council and Parliament Reach Deal on New Rules to Cut Methane Emissions in the Energy Sector (Nov. 15, 2023); *See also* May 2023 Amendments 001-267 to the EU Methane Proposal.

54 Tim Boersma, Anne-Sophie Corbeau, & Robert Kleinberg, *How New European Rules Advance the Global Methane Pledge*, Columbia Center of Global Energy Policy (Nov. 21, 2023).

55 European Council, *supra* note 53; s*ee also* May 2023 Amendments 001-267 to the EU Methane Proposal, Amendment 61 (expanding site-level measurements to include remote sensing platforms and fixed sensors).

emissions.[56] CBAM is a cross-border program designed for exporters of goods to the EU to reduce carbon emissions on high carbon-intensity goods, including electricity, steel, hydrogen, and cement.[57] Further, other jurisdictions may be spurred by the EU's example to create cross-border methane regulation and pricing mechanisms of their own. As these programs develop, questions about how best to integrate remote sensed data into implementation and enforcement will continue to arise, including questions about data sourcing, validation, and reliability. Moreover, implementation of any such cross-border policy should be carefully designed to improve, not erode, international cooperation, without sacrificing policy ambition.

c. Promoting the exchange and accessibility of methane data, particularly for use in developing countries.

As the coverage and frequency of remote sensing applications improve, robust streams of data can strengthen characterization of methane emissions worldwide and improve jurisdictions' understanding of emissions within their borders in both developed and developing countries. Sharing these data with developing countries has especially strong potential to advance methane control by strengthening technical, assessment, and regulatory capacity in under-resourced jurisdictions.

This value is highest when data are exchanged from and across multiple platforms. Because remote sensing platforms are optimized for different spatial and temporal resolution and coverage, information exchanges that draw from multiple data sources can help create a fuller picture than any single source could alone.[58] For instance, in 2022, a combination of three satellites were used to detect a large methane leak near the Hassi Messaoud oil field in Algeria; one satellite identified that the leaking facility had been emitting continuously for six days, one identified the precise source of the leak at a particular well, and a third (alongside the first) showed that the source of the leak had been burning methane consistently over the previous four months, suggesting that a gas well blowout had caused the leak.[59] Another study similarly used three different satellite data providers to conduct spatial and temporal analysis of methane emissions sources to investigate methane leaks in Turkmenistan, a large methane hotspot.[60]

These instances demonstrate the value of systems that compare and exchange remote sensed data and provide a range of data at various spatial, temporal, and spectral resolutions. Making such systems accessible to developing countries could help to jump-start methane control programs in areas that have historically not had the technical capacity to support such programs.

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56 See Clausing et al., *supra* note 51 at 18-19.

57 European Commission, Carbon Border Adjustment Mechanism (last visited Nov. 29, 2023); Philip Blenkinsop & Kate Abnett, *EU Launches First Phase of World's First Carbon Border Tariff*, Reuters (Oct. 2, 2023).

58 Siwei Zhang et al., Atmospheric Remote Sensing for Anthropogenic Methane Emissions: Applications and Research Opportunities, Sci. Total Envt. (Oct. 1, 2023).

59 Sudhanshu Pandey, *Daily Detection and Quantification of Methane Leaks Using Sentinel-3: a Tiered Satellite Observation Approach with Sentinel-2 and Sentinel-5p*, Cornell University (July 31, 2023).

60 Itziar Irakulis-Loitxate, *Satellites Detect Abatable Super-Emissions in One of the World's Largest Methane Hotspot Regions*, ACS Publications (Feb. 1, 2022).

d. Providing technical support and data to highly exposed communities.

Advances in the availability and coverage of methane remote sensing technology can be used to empower local advocates and preserve the health and safety of environmental justice communities. Although methane is often considered a non-local pollutant, methane leaks can jeopardize local communities' health and welfare in several key ways, including through (1) formation of ground level ozone through oxidation; (2) the emission of toxic co-pollutants, such as volatile organic compounds, benzene, particulate matter or odorants; and (3) depending on the emissions source, ignition and explosion risk.[61] Having reliable, real-time (or near-real-time) access to information about methane emissions, along with tools to interpret that information, can strengthen communities' hand in working to protect public health, and can help to correct informational imbalances among community members, the industries that affect them, and regulators.

In 2015, a massive methane leak near Porter Ranch, California vented over 100,000 tonnes of methane and ethane into the atmosphere over the course of three months. Nearby residents reported severe headaches, nausea, skin rashes, and nosebleeds, and thousands of residents were forced to relocate from their homes. Near the start of the gas leak, residents reported smells and illnesses to the gas company that operated the leaking storage facilities, but the gas company did not acknowledge the leak for five days, even after it was confirmed using satellites and other remote sensing technology.[62] The responsible gas company later drew significant criticism for failing to follow best safety practices and denying the existence of the leak.[63] In this instance, despite residents reporting that a leak had likely occurred, they did not have access to available remote sensing data—or the necessary expertise—to verify or pinpoint the leak. In Colorado, community groups have used local air monitors to dispute oil and gas operators' claims that methane emissions had significantly decreased within local air basins.[64] However, because the community groups conducting the monitoring did not have access to the same satellite data as the oil and gas operators, they were unable to dispute the monitoring data under a common remote sensing framework and their evidence was deemed inconclusive by the Air Quality Control Commission.[65]

These examples show the importance of community-level access to remote-sensed data and technical assistance to interpret the data. Providing these data to communities near facilities would improve equity: Low-income and minority communities are among those closest to, and most at risk from, major emissions sources, such as oil and gas operations, landfills, and

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61 United Nations Environment Programme & Climate and Clean Air Coalition, Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions 22-23, 42-43, 51 (2021).

62 *See, e.g.*, Earth Observatory, Imaging a Methane Leak from Space (2016), Imaging a Methane Leak from Space (2016); Juan Gónzalez, Interview, *Erin Brockovich: California Methane Gas Leak is Worst U.S. Environmental Disaster Since BP Oil Spill*, Democracy Now (Dec. 30, 2015).

63 Gregory Yee, Tony Barboza, & Leila Miller, *SoCalGas Agrees to Pay Up to $1.8 Billion in Settlement for 2015 Aliso Conyon Gas Leak*, LA Times (Sept. 21, 2021).

64 Jim Crompton et al., *Colorado (CDPHE/AQD) Rule Making Verifying Methane Emissions Reporting*, Payne Institute for Public Policy 31-32 (June 2023).

65 *Id*. at 31.

dairies.[66] In recognition of these disparities, several non-governmental organizations, such as the Global Methane Hub, have committed resources to providing technical support and assistance to environmental justice communities for accessing and using methane data.[67]

Governmental, intergovernmental, and non-governmental entities will have an opportunity to offer remote sensing data—as well as training and technical assistance—to community-based organizations near large methane sources. This would allow local communities, often those with the highest stakes in preventing and fixing methane leaks, to monitor for community health and safety risks, such as super-emitter events and instances of facility operation that violate permit conditions. With appropriate support, such community-based organizations could also provide additional oversight capacity to overburdened regulators.

VI. Challenges to the Effective Legal and Regulatory Use of Remote Methane Observations

To take advantage of these and other opportunities to use new remote sensing data in methane regulation and control, regulators and stakeholders must confront and overcome several essential challenges. Some of these challenges include: (1) lagging understanding among policymakers about remote sensing data and their use; (2) data gaps; and (3) difficulties in reconciling inconsistencies in data.

a. Lagging understanding among policymakers about this data and how to use it.

For new remote sensing data to make a rapid and significant difference in methane control, policymakers must know what data are available, how to access and interpret them, and their limitations. The speed of advances in methane remote sensing technology has thus far generally outpaced policymakers' ability to incorporate new data from these advances. Awareness of these advances and their significance remains limited among officials and legislators, even in many well-resourced jurisdictions and especially in those with more limited capacity.

Both the opportunities presented by these new data and their limitations are important to convey to policymakers in terms that are relevant to their use of the data. Although uses will vary widely across jurisdictions, some needs are common. Information about data characteristics and limitations should be translated from technical language into forms more understandable to regulators. The implications of that information for designing regulatory controls should be analyzed in a way that takes advantage of overlapping or similar authorities, even as it is sensitive to local policymaking contexts and constraints.

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66 Erin Murphy & Joe von Fischer, *Methane Gas Leaks Present Environmental Justice Concerns*, Envtl. Def. Fund (May 11, 2022); Joan A. Casey et al., Climate Justice and California's Methane Super-Emitters: An Environmental Equity Assessment of Community Proximity and Exposure Intensity, Nat'l Library of Medicine (Nov. 2, 2021) (providing California-specific analysis).

67 Global Methane Hub, CA Budget Passes: First-of-Its-Kind $100 Million Climate Initiative Will Slash Methane Emissions in California Via Satellite Monitoring (July 13, 2022) ("climate-centered philanthropies and organizations – including the Global Methane Hub – will provide funding to local environmental justice organizations so that they take the data provided by the Methane Accountability Program and leverage it towards disparity-closing solutions.").

To overcome these challenges, there is a need to inform law and policymakers in diverse jurisdictions about these advances and their significance and to work collaboratively with them to identify and develop new approaches to methane control that take advantage of new observational capabilities. Case studies that illustrate existing and potential regulatory strategies can be useful as models across jurisdictions and emission sectors with similar characteristics. Initial and ongoing forms of technical support and other capacity building efforts may be particularly helpful to regulators in the early years of policy development.

b. Data gaps.

Incomplete and missing information can make it difficult to use remote sensing data to reliably estimate, and therefore regulate, methane emissions. Data gaps generally come in two forms: missing information about emissions themselves, and missing information about other characteristics of the sources being surveyed or their environment.

Many methane sources have highly variable emissions, with large amounts of methane emitted intermittently. Satellite passes that occur infrequently thus risk either over-estimating or under-estimating emissions, depending on whether a flyover coincides with, or entirely misses, a high-flow emissions event. Moreover, routine maintenance events such as "blowdowns"—during which natural gas is purposely vented to the atmosphere to relieve pressure built up during well or pipeline operations—will release large amounts of methane into the atmosphere over a short time. Remote sensing equipment can mistake these events for large methane leaks due to low frequency sampling, which can result in the potential false reporting of leaks.

These kinds of emission data gaps can potentially be addressed by increasing the number and diversity of remote sensing platforms. A larger network of remote sensing instruments would, for example, improve coverage in detecting and quantifying super-emitters and other large emissions events.[68]

Other emission data gaps are harder to address. Because the completeness and detection limits of satellite instruments vary with conditions such as cloud cover, aerosols, sun angle, and wind, persistently adverse weather or surface conditions can make gathering reliable data in some regions of the globe difficult. For instance, many areas in Russia and Canada—among the world's largest oil and gas producers—experience months-long periods when measurements are limited by sun angle, cloud cover, and surface conditions.[69] In these regions, it may be important to rely on alternative remote sensing technologies, such as active detection technologies (which use laser, rather than ambient, light to detect methane gas) on aircraft or ground vehicles.[70]

A final type of emission data gap is anticipatory. Policymakers who construct regulatory regimes that rely on remote sensed data will need some assurance that such data will be reliably available

[68] Evan D. Sherwin et al., *Single-Blind Validation of Space-Based Point-Source Detection and Quantification of Onshore Methane Emissions*, 13 Sci. Reports 3836 (Mar. 7, 2023).
[69] Mozhou Gao et al., *Global Observational Coverage of Onshore Oil and Gas Methane Sources with TROPOMI*, Nature (Oct. 5, 2023).
[70] Inayat Singh, *Study Using Laser Technology Suggests Canada Overlooks Key Sources of Methane Emissions*, CBC News (July 15, 2021).

into the future. But the current business models that support methane detection satellites frequently rely on uncertain and time-limited forms of funding, such as from nonprofits and one-time governmental budgetary allocations, or on funding from private industry, which may not have incentives to share all data transparently. Jurisdictions will face the challenge of encouraging the development of more robust satellite industries and data processors, reducing the industry's current reliance on philanthropy and self-interested actors.

Next, data providers and regulators also confront gaps in information about the characteristics of the sources being surveyed and their environment. To use observations of methane detected in the air to accurately characterize the methane source often requires information about facilities on the ground, their current operations, and the weather. For example, because wind determines how a methane plume disperses, attributing an observed plume to a source requires accurate wind information at precise times and locations, which is often unavailable.

Information about facility structures and operations is also critically important for interpreting remote sensed data. Blowdowns, for example, can be more accurately characterized if facility maintenance events are routinely and accurately reported, meaning that better reporting of maintenance events can reduce this source of uncertainty. Data about the location, approximate production, and operator of wellheads, gas pipelines, and well-pads are necessary to target remote sensing equipment at facilities with the highest risk of leaks; to notify operators and regulators of facility leaks; and to understand diffuse emission patterns in the region, particularly seasonal or diurnal patterns that can obscure methane emissions sources. Such data is frequently unavailable, especially for smaller and mid-sized operations, as well mid- and downstream operations.

Indeed, EDF's PermianMAP project, which provided near real-time remote sensed data on emissions within the Permian Basin, sourced facility data from multiple state agencies and private data providers to attribute leaks to operators of upstream and midstream facilities, yet was still was unable to attribute several large leaks to particular oil and gas operators without additional facility-level information.[71] The nonprofit coalition Climate TRACE has aimed to catalogue asset owners of high-emitting facilities across numerous sectors, but this platform does not yet provide complete, granular GIS data linking particular equipment with asset owners.[72]

c. Difficulties in reconciling inconsistencies in data.

As the number and diversity of data providers grow, policymakers will increasingly confront difficulties in validating data using consistent methodologies, and in reconciling disparities among emissions reports from multiple observers. These problems are, in some ways, the flip side of the challenges of insufficient data described above. Too much data, if not properly vetted, characterized, validated, and understood, can be a problem too.

Satellite methane data providers include a growing constellation of for-profit companies, non-profit organizations, and public-private partnerships, which make data available in varying forms and with varying degrees of processing, validation, and transparency about technical limitations.

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71 Environmental Def. Fund, Methodology for EDF's Permian Methane Analysis Project 2-3 (Mar. 25, 2022).

72 Christy Lewis, How to Parse Asset Ownership in Climate TRACE Data, Climate TRACE (Feb. 26, 2023).

Differences in satellite capabilities and operations, data processing techniques, and other factors can lead to widely disparate emissions estimates. This heterogeneity will only grow and can lead to opportunities for both regulated parties and regulators to cherry-pick results that are more favorable from their perspective, or to obfuscate adverse data. Satellite providers may face perverse incentives to supply parties with favorable emissions numbers that do not accurately estimate total emissions.

While operators' interest in maximizing the collection and beneficial use of methane may create some demand for the most accurate remote sensing data available, risks remain of underreporting emissions in order to greenwash or to minimize penalties or fees, such as the methane waste charges included in the US Inflation Reduction Act of 2022.[73] Effective use of remote sensing data in methane control will require appropriate responses to instances of poor-quality or contradictory data. Agencies and third parties seeking to deploy remote sensing technologies to promote enforcement efforts and accountability will have to ensure that their credibility is not undermined through documented under- or over-estimates.

There are a few potential solutions to this challenge. Collecting more data, aggregating sources of data across multiple platforms, and making data publicly available can all help to address the consistency problem to some degree, but likely can't solve it alone. Governments and nonprofit organizations will likely have to establish consistent standards for describing data integrity and limitations and invest in shared validation frameworks. These steps would yield more consistent results and help to achieve more transparency about the limitations of these data. This, in turn, would help policymakers better understand how to put data to good and fair use. Such standards would also increase trust in data from third-party or foreign sources; ease international tensions related to cross-border provision of information about higher-than-recognized emissions; and assist with satisfying the evidentiary and procedural requirements of enforcement actions that that rely on significant rewards or penalties.

VII. Conclusion

A strong and global suite of policies that effectively take advantage of emerging remote sensing technologies has the potential to drive major reductions in methane emissions. Some governments have already proposed or adopted ambitious policies designed to promote the use and deployment of these technologies, but the field is underdeveloped and significant opportunities exist to expand these uses to new sectors, regulatory forms, and jurisdictions. However, substantial challenges remain, related to developing new regulatory approaches that take advantage of new information while also meeting applicable jurisdiction-specific procedural, evidentiary, and mandate requirements; potential barriers to accessibility and trust in data from third-party or foreign sources; international tensions related to cross-border provision of information about higher-than-recognized emissions; and capacity-building to ensure that relevant facility operators, legal authorities, and affected communities have the capability to receive, interpret, and use the new data.

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[73] Romany Webb, *The New Methane Emissions Charge: One (Limited But Important) Stick in the Inflation Reduction Act*, Climate Law Blog, Sabin Center (Aug. 23, 2022).