What are we testing in Australia and why use controlled releases?

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St. Francis Xavier University (StFX) and Stanford University (Environmental Assessment and Optimization Group) have spent years running controlled-release experiments in North America to test methane measurement technologies (EREF, 2026; Sherwin et al., 2023; El Abbadi et al., 2024). The idea is simple: we release methane through a metered system at known rates while participating teams attempt to detect and quantify those emissions without knowing in advance where or how much methane is being released. As operators of the experiment, we hold one basic advantage: we know the answer. Every team's result can be evaluated against an experimental truth — the metered methane release rate.

We are now bringing this controlled-release approach to Australia to simulate an open-cut coal mine and evaluate measurement technologies and methods, supported through the UN Environment Programme's International Methane Emissions Observatory (IMEO). The study is motivated by

persistent differences between official estimates and atmospheric measurements of methane emissions from Australian open-cut coal mines (Sadavarte et al., 2021; Wright et al., 2025). Even different measurement methods do not always agree with one another (Borchardt et al., 2025). Why is this the case? Rather than assuming one approach is "right" and another is "wrong," a more interesting question is whether different methods are observing different aspects of a highly complex system.

Open-cut mines present an unusual context for methane measurement. Methane is released from point and area sources across the site, within a basin-like structure that can alter airflow. Under some conditions, ventilation may be efficient. Under others, air may move slowly and stagnate, accumulating methane over time (Chen et al., 2023) and creating an important issue for the measurement system. A system may observe a large methane mass in the pit, but that mass could reflect either a high current emission rate or several hours of accumulation under sluggish ventilation. Different platforms may observe different parts of that methane mass, over different time periods and spatial scales. These effects could plausibly explain some of the disagreement among existing measurements, and their departures from the true instantaneous emission rate.

The basin-like setting of a coal mine is distinct from the flat oil and gas controlled-release sites used in many Stanford studies, and from the convex, dome-like landfills where StFX has conducted controlled-release validation (Hossain et al., 2026). Our question is therefore specific: **How well do available methane measurement approaches perform when emissions occur within a basin-like environment?** This is a question many have asked but for which we have no definitive answer, because until now an experimental facility designed specifically to recreate this environment has not yet been built.

This is, at its core, a science study: an experiment to validate measurement approaches. It is worth being clear about what it is not. We are not building or auditing an emissions inventory. Inventories represent emissions over a defined reporting period, and they typically combine estimation methods, operational data and, increasingly, measurements, all assembled to meet statistical and reporting requirements. That is a larger and more expensive exercise than the typical uses of methane measurement in industry.

In high-emitting sectors like oil and gas where atmospheric measurement is used extensively, we see technologies deployed at several scales (Fox et al., 2019), and for different purposes. Some are designed to quantify and validate total site emissions. Others detect, locate or quantify individual sources. The latter is particularly useful for operational intelligence, identifying where emissions

occur, diagnosing changes and determining whether mitigation or operational adjustments are working. These are related but different tasks, and some systems are capable of both. The study is therefore not a simple vendor competition with a singular evaluation metric. Its purpose is to understand which measurement approaches are suited to which questions, in this operating environment, and with what limitations.

In our past studies, we've been interested in metrics including quantification bias and uncertainty, precision across repeated measurements, localization accuracy, and rates of true positives (correct detections), false positives (false alarms) and false negatives (missed detections) (Ilonze et al., 2024). A common sensitivity metric is the 90% probability-of-detection emission rate: the source strength at which a system is expected to detect methane nine times out of ten under the tested conditions (Tarakki et al., 2026).

Although the science will be centred on measurement, recreating the coal-mine context is essential. Our release system must distribute known methane flows among multiple nodes, including both point and area sources, at realistic magnitudes and spatial scales. The pit geometry must also generate representative airflow and transport behaviour.

That is where much of the difficult work lies. Building the experimental apparatus, designing the experiments and metrics, and convening the measurement teams, is familiar work for us. The harder challenge is recreating the environment, modelling pit-scale wind and methane transport, designing realistic but interpretable release scenarios, and working with Australian partners to identify and prepare the right site.

In subsequent posts, we will describe project pieces and status in more detail: the measurement systems that we'd like to evaluate and why; the distinction between an experimental protocol and an experimental plan; the wind and dispersion modelling; the controlled-release infrastructure; the project team including our local partners; and what earlier controlled-release studies have taught us about what works including how to drive improvement amongst a group of technology providers.