
Root cause analysis of emission points identified in the OGCI Satellite Monitoring Campaign

Insights and lessons learned

CARBON LIMITS

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Overview

Satellites are transforming the amount of information available to identify large methane emissions, often called super emitters. In 2021, OGCI launched the Satellite Monitoring Campaign (SMC) to track methane emissions from oil and gas operations in several countries. In collaboration with GHGSat and Carbon Limits, OGCI used advanced satellite technology to detect significant methane emissions and engaged local operators for timely mitigation.

Following a successful pilot in [Iraq](#), the SMC was expanded to Kazakhstan, Algeria, and Egypt to support substantial methane mitigation through timely access to high-quality data and proactive operator engagement. Sites were selected based on historic methane emissions, suitability for satellite monitoring, and feasibility of operator engagement. Over 530 high-resolution satellite observations were performed at sites between 2022 and 2023; detections were followed with operator engagement to confirm emission

sources. Overall, the campaign demonstrated that satellite monitoring, combined with operator engagement and technical support, can rapidly identify and help mitigate major methane emissions sources in global oil and gas operations. A [report](#) published in 2023 showcased the findings of this effort.

In addition to identifying possible super emitters, liaising with operators to inform them of the emissions, and supporting their understanding of mitigation options, the SMC identified an opportunity to leverage the collected emissions data towards a subsequent root cause analysis (RCA) effort. This initiative aimed to collaborate further with operators to uncover systemic issues contributing to emissions in their operations. This report is intended to share some of the lessons learned on RCA and the use of satellites to inform inventory and mitigation strategies, aiming to provide useful insights for operators and other actors in the methane space.



Photo: Adobe Stock

Mitigation strategies

Highlights and insights

Mitigation can take various forms: equipment may be repaired, upgraded, replaced, or decommissioned. Alternatively, efforts may focus on improving maintenance practices and operational procedures. In some cases, mitigation addresses upstream root

causes rather than the emission source itself. Several emission sources identified during the SMC are highlighted in case studies below, based on detailed engagements with participating operators.

Mitigation category

Example of one RCA process



Repairing/restoring the equipment

Repair of a malfunctioning shut-off valve

During an RCA engagement with an operator after a satellite detection, a malfunctioning shut-off valve was identified as the likely cause. The operator confirmed the issue and implemented corrective maintenance to restore proper valve operation. This action fully mitigated the source, based on no detections during subsequent observations.



Change of maintenance practice

Collecting liquids in truck-mounted tank for further processing, rather than dumping in a pit

After a satellite detection, RCA discussions with the operator confirmed an emission source at a disposal pit near a low-pressure natural gas well pad. Emissions occurred during periodic liquid unloading activities (about once a month for less than an hour) when well flow was diverted to the pit to evacuate (unload) liquids accumulated in the wellbore, which can restrict gas flow. These liquids contain entrained natural gas, resulting in methane emissions when unloading occurs outside the production process.

Follow-up discussions revealed that practices have changed since these emissions were first observed. Instead of dumping liquids in pits, operators now use mobile tanks mounted on trucks to collect and transport liquids for processing and gas recovery. Analysis of third-party satellite data over the past six months shows no emissions from this source since the updated practices were implemented¹.

¹ This information, though encouraging is not a confirmation of full mitigation which could be only performed onsite.



Addressing emission upstream of source

Installation of upstream separators to reduce the amount of gas reaching the tanks

Based on analysis of a satellite detection and operator confirmation, an emission source was identified as venting from floating roof tanks. Potential causes included venting through thief hatches and floating roof design features to avoid gas buildup. Emissions persisted for about 11 months based on satellite data. Following engagement, the operator installed several upstream separators to improve gas separation and reduce the amount reaching the tanks. Analysis of third-party satellite data shows no emissions from these tanks after the improved separation was implemented. This is an example where the mitigation strategy is not directly at that detected point of emission.

In some cases, mitigation took place immediately after the root cause was identified (for example, repairing a valve). However, this was often not possible for a variety of reasons:

- Many mitigation measures required capital investment, which could require additional approval or cross-departmental coordination.
- Capital investment that required new equipment entailed additional time to procure and install.
- The need to thoroughly evaluate and minimize HSE risks prior to mitigation; this may require temporary

equipment shutdowns, rerouting of certain processes, or confined space entry.

- Some repairs or restoration work can only be performed during planned maintenance shutdowns.

One of the key learnings was that there is not a one-size-fits-all mitigation solution. Successful and cost-effective mitigation depends on many factors, including the emission source, potential gas capture and utilization routes, common practices, site layout, gas composition, and the remaining life of the field.

Root cause identification process

Over the last few years, the team worked to identify root causes for hundreds of emission sources, resulting in lessons learned on the RCA process.

- **On-the-ground detection** equipment is highly effective for identifying emission sources and often helps determine their root cause. All the surveys combining satellites and follow-up on-the-ground optical gas imaging with a camera resulted in successful RCA, though not all operators globally had access to that equipment.
- However, when on-the-ground detection equipment is not available, **methane satellite observations, combined with aerial imagery, proved effective for initial identification** of the emitting equipment. This method requires (i) high-resolution satellite imagery to identify equipment or source types and (ii) areas with low equipment density to accurately pinpoint the most likely source.

- **Site-specific detailed information is often crucial in determining a root cause:** Operational logs may provide insights on whether e.g. a blowdown event was occurring at the time of the emission observation. Design documents, like P&IDs, might reveal that a separator is undersized compared to actual operating conditions, reducing retention times and causing gas to carry through and later volatilize in downstream operations. Visual inspection could result in identification of a loose valve. These insights are irreplaceable in confirming the root cause of the emission as well as identifying the frequency/recurrence of such events.
- **If the available information is insufficient for identifying a root cause,** the area should continue to be monitored at regular intervals (e.g. via satellite) to determine if the source is recurring. This may need to be combined with site-based efforts e.g., improving operational logs or performing additional inspections.
- **The ability to promptly investigate and verify potential emission sources in the field is essential** for quick and targeted mitigation, as some emissions are intermittent or situational. A delayed response can mean the emission stops on its own (losing the chance to locate it and identify the root cause with an eye towards future prevention). Root cause identification becomes more difficult even a few weeks from the event.

Integrating satellite detections into emissions inventories

Information obtained during the RCA process can help companies improve their emissions inventories. Satellite-based detections may identify sources that are not included in the existing methane inventory. The information from the satellite observation may not necessarily be directly used in inventory calculations, but information obtained in the process could be helpful to making emission estimates. For example, a satellite detection could identify a source that is best estimated using engineering estimates or models when appropriate. In other cases, the satellite-based observation may be the best available information and estimates could be based on the direct emission rate measurements and the emission event duration, but it is important to account for emission rate variation during the event.

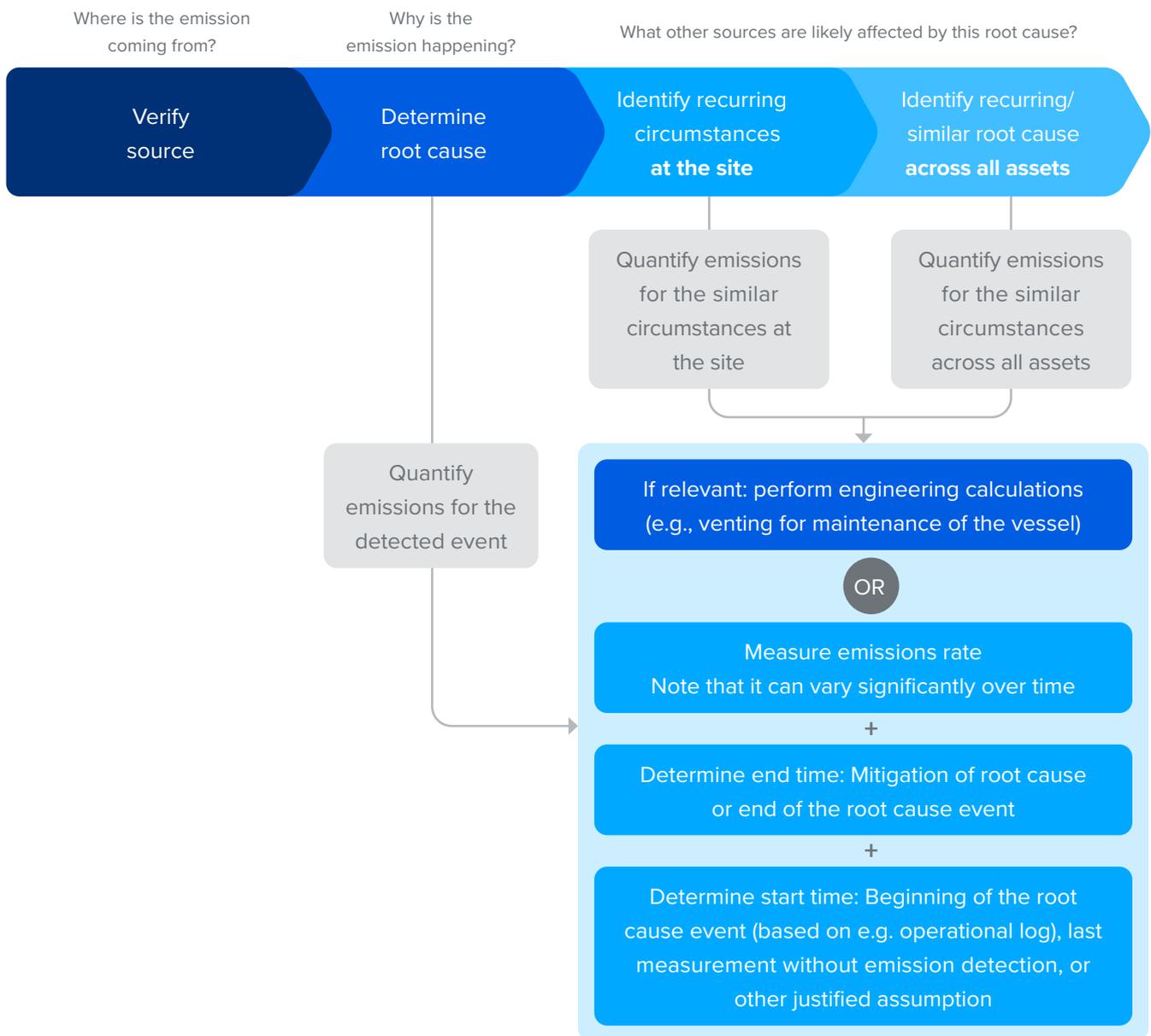
In determining the duration of the emission event, the estimated start date will depend on the root cause

of the emission. For an emission source triggered by an operational event, the start of the emission can be correlated to the start of the activity. For other emissions sources, different approaches can be considered. It can e.g. be determined based on half the time since a survey confirmed there was no emission. The end date depends on either when the relevant operation ended (for event-based emissions) or when mitigation action was implemented and verified.¹

Identifying the root cause of a super emitter is a great opportunity to identify other potential emission sources by determining where there are **similar circumstances at the same asset or at any other asset**. After root cause analysis has been completed at a single source, operators can evaluate the potential for recurring events across their asset portfolio and update their emissions inventory accordingly, with an eye towards learning and methane emission prevention.

1 [A Practical Framework for Oil and Gas Operators to Estimate Methane Emission Duration Using Operational Data.](#)

FIGURE 1. Process for integrating satellite-based detections into emission inventories.



Source: Carbon Limits

Conclusions

The OGCI SMC demonstrates the powerful results possible when cutting-edge technology and industry collaboration are combined to address methane super-emitters in oil and gas operations. The campaign produced a range of outcomes—from quick wins to persistent challenges—each offering valuable lessons for industry and policymakers. Prompt investigation and verification of potential emission sources in the field are essential for effective mitigation, as some

emissions are intermittent or situational. Delayed responses can result in missed opportunities to identify and address root causes, which become harder to determine as time passes, and reduces the potential for learning to inform mitigation.

Data alone doesn't cut emissions – data combined with mitigation action does.



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