Vehicle-based fugitive emission detection and attribution within AB energy developments: Lessons from extensive measurement campaigns

2017 Canadian GHG Emission Reductions Forum

Liz O’Connell, on behalf of Dave Risk, Ph.D.
October 23rd, 2017
FluxLab Research Group, St.FX University, NS

30 member research group

Leak detection technologies for oil and gas applications

Work with industry and regulator partners, using a variety of platforms such as truck, drone, satellite - to tackle gas measurement challenges on a range of scales.
PTAC - AUPRF Project

June 2016-June 2017, Extended 1 year with NSERC CRD Grant

- What’s our baseline in Canada?
- Are the inventories accurate?
- Do we have super-emitters?
- Particular developments with issues?
- Are emissions persistent or episodic?
- What is the low hanging fruit?
- What volume is being emitted? Is it over or under proposed regulations?
- What class of infrastructure emits the most frequently? Severely?

Target Sites: Each 2 weeks in fall 2016
3 developments with ongoing air / GHG issues

Lloydminster (heavy crude oil)
Peace River (oil sands)
Medicine Hat (conventional gas)
Mobile measurement methods

**Field:** Vehicle-based data acquisition: Multiple gases

**Lab:** Signal Processing Algorithms:

- a) Establish ambient background
- b) Identify plumes by gas ratio fingerprints
- c) Back-trajectory to emission “priors”
- d) Minimum inventories or volumes
- e) Interpret, visualize

Targets vented, combusted, and fugitive emissions

---

Measures ~5 gases, which record at 1-2 hz.
Addressing Uncertainties

**Detection Confidence:**
Control routes give us a 95-99% confidence in detection, even for anomalies as small as 10 ppb CH₄.
- Every route done in triplicate.
- **Multi gas, ratio-based detection** = fewer false positives from non-industrial sources.

**Attribution Confidence:**
More room for error with attribution.
- Higher density areas = lower confidence.
- On-pad surveys = higher confidence over road-based
- Rigorous statistical requirements to flag infrastructure as emitting

**Sensitivity:** 10-100X higher than handheld tools (FID or FLIR). Wind direction must be favorable.

On-Pad at 15 m, $<1 \text{ m}^3/\text{d (from 8 m}^3/\text{d cap)}$  
(100 wells/d)
On-road at 60m, $<10 \text{ m}^3/\text{d (from 8 m}^3/\text{d cap)}$  
(400 wells/d)
On-road at ~350m, $<86 \text{ m}^3/\text{d (from 8 m}^3/\text{d cap)}$  
(400 wells/d)
### Campaign Statistics

8,349 kms of surveying sampled 2,486 pieces of O&G infrastructure 3X, from 59 unique operators

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max CH₄ (ppm)</td>
<td>5.54</td>
</tr>
<tr>
<td>Mean and S.D. CH₄</td>
<td>2.03 ± 0.15</td>
</tr>
<tr>
<td># of Data Points</td>
<td>152,486</td>
</tr>
<tr>
<td>Infrastructure Surveyed</td>
<td>979</td>
</tr>
<tr>
<td>Thermogenic plumes measured</td>
<td>1,713</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max CH₄ (ppm)</td>
<td>3.69</td>
</tr>
<tr>
<td>Mean and S.D. CH₄</td>
<td>1.97 ± 0.10</td>
</tr>
<tr>
<td># of Data Points</td>
<td>153,142</td>
</tr>
<tr>
<td>Infrastructure Surveyed</td>
<td>458</td>
</tr>
<tr>
<td>Thermogenic plumes measured</td>
<td>898</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max CH₄ (ppm)</td>
<td>64.06</td>
</tr>
<tr>
<td>Mean and S.D. CH₄</td>
<td>2.39 ± 1.74</td>
</tr>
<tr>
<td># of Data Points</td>
<td>192,500</td>
</tr>
<tr>
<td>Infrastructure Surveyed</td>
<td>1,049</td>
</tr>
<tr>
<td>Thermogenic plumes measured</td>
<td>3,125</td>
</tr>
</tbody>
</table>
Concentration – Duration Analysis

Sustained methane over differing time intervals

- Regional anomalies
- Lloyd is an anomaly amongst Canadian developments.

- Similar to global background.
- Smallest regional anomalies
- Lower infrastructure density

- Regular small deviations.
- Small regional anomalies.
- High density of infrastructure

Horizontal line is global atmospheric CH₄ background concentration (~1.88 ppm)
Lloydminster has **highest** emitting frequency and severity for both wells and facilities. → CHOPS-related methane emissions originates from wellhead (casing) **venting** or tank venting = significant source of emissions in AB.

**Tank venting** and **active** infrastructure most frequent source of emissions

- 5,736 oil and gas related plumes were detected across all 3 campaigns.
Comparative Studies

Montney Shale Gas

A mobile-based study by Atherton et al. (2017) found 0.47 of active wells emitted over a minimum detection limit of 0.59 g/s, which is very comparable to the 0.53 calculated in the Alberta Montney near Grande Prairie, using OGI ¹.

Alberta Greenpath OGI-Study (2016) ¹

Detected 313 leaks or vents from 395 unique facility locations in 6 regions

= 8 leaks or vents visible via OGI for every 10 facilities inspected

Despite the difference in technology, there is consistency in emitting frequencies between this study and ours.

Thurs, OGI + mobile approaches work well as a tandem approach.

The results of our study reinforce the emission patterns of the GreenPath study, across a larger (~4x) sample size.

Large inter-development differences
Moving Forward: Measurement and Mitigation

An integrated approach is key to operational monitoring

Super-emitter profile: \(~10\%\text{ of facilities are responsible for }\sim90\%\text{ of emissions}\)\(^1\)

Non-exhaustive approach involving mobile and small-scale tools for volume/point source detection would help achieve reduction targets at \(~2-3 \times\text{ lower measurement cost}\) over exhaustive OGI.

**Example – OGI only:**

- OGI inspection at 2.7hrs/well site\(^2\), $100/hr
- Example development with 400 sites/30% emitting freq.:
  - $76K spent on measuring zeros
  - $32K spent on leak detection at appropriate sites

\[= \text{$108k total}\]

**Mobile + OGI:**

- $16K for pre-screen with mobile: $4K/100 sites/day
- $32K for OGI, targeting 120 known emitting sites

\[= \text{$48K total}\]

**Not one technology answers all monitoring needs.**

---

1: Zavala-Araiza et al. (2015)
2: ICF International, 2014

WWW.FLUXLAB.CA
Some developments are more emission-prone than others
All infrastructure classes emit to some degree
Tank battery vents are a common emission source
Volume inventories from bottom-up studies are often smaller than top-down
Mobile surveying effective to locate problem sites quickly
OGI and mobile are complimentary, with comparable results in similar developments

Positives:
Sites with historic odour or H₂S issues are tighter, indicating that regulators + industry can solve problems
Potential for significant improvement if efforts focused on largest emitters