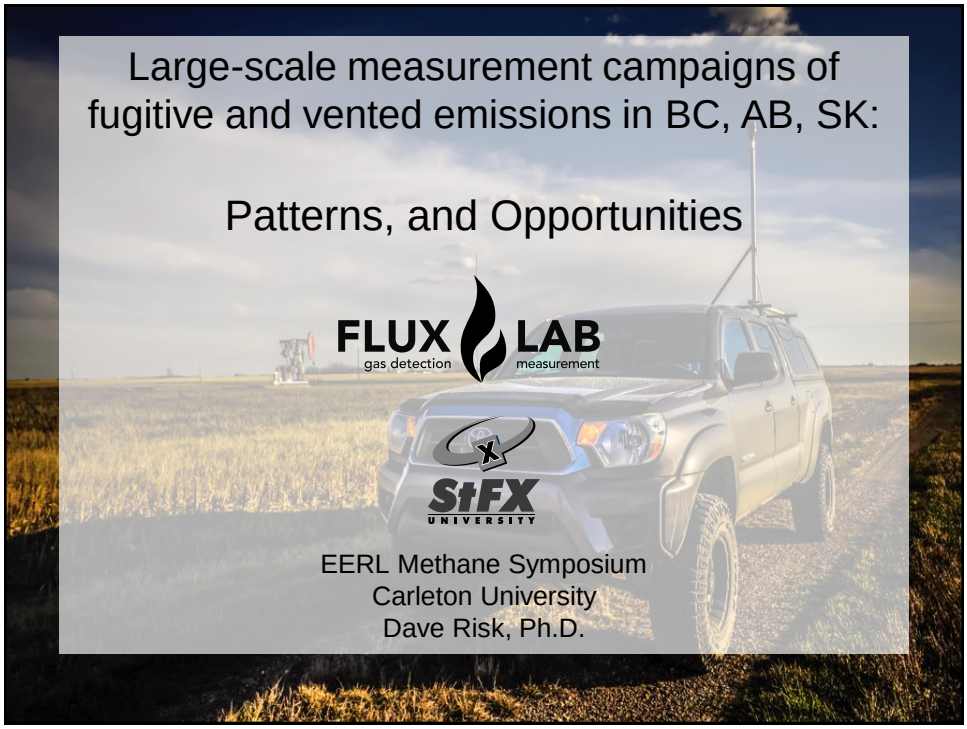


Large-scale measurement campaigns of fugitive and vented emissions in BC, AB, SK:

Patterns, and Opportunities

FLUX LAB gas detection measurement

StFX UNIVERSITY

EERL Methane Symposium
Carleton University
Dave Risk, Ph.D.

Who We Are

FLUX LAB gas detection measurement

www.fluxlab.ca

25 member research group at St. Francis Xavier University.
Gas measurement in industrial and ecological landscapes. Soil, truck, drone, satellite. Sensors and computing, measurement needs of operators.

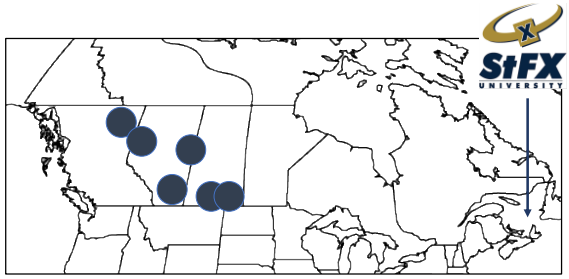
Recent Montney truck-based measurement study:

Atmos. Chem. Phys., 17, 1–16, 2017
https://doi.org/10.5194/acp-17-1-2017

Atmospheric Chemistry and Physics EGU

Mobile measurement of methane emissions from natural gas developments in northeastern British Columbia, Canada

One of several regional studies funded by
- Industry 26%
- Government 7%
- Ind-Gov 52%
- NGO 15%



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Today's Presentation

Update on measurements we've made in 6 developments

- Road-based campaigns in a mobile lab truck
- Fugitive AND vented emissions
- 6 locales, 3 provinces, varied production styles
- Emission rate estimates from a large population

Measurement baseline across Canadian developments?

- Patterns
- Implications for Mitigation and Measurement

Methods

Observations | Geochemistry | Quantification | Attribution

- Four-part methodology
- Adhere to principles found in (non-methane) air regulations
- Large datasets shift challenge to mining, computation

Methods

FLUX LAB gas detection measurement

Observations | Geochemistry | Quantification | Attribution

a) Lay out routes (100-200 km) to pass maximal infrastructure (100-400 pcs)
b) Analyzers in truck – same that measure global GHG standards
c) Collect geolocated measurements 5 characteristic gases, isotopes, @1Hz
d) ~3-8 routes per development, each repeated 3 times (different days)

Direct Outcomes: Regional Methane Norms

Uncertainty: Low. Analyzers meet or exceed expectations for lab analysis

Methods

FLUX LAB gas detection measurement

Observations | **Geochemistry** | Quantification | Attribution

a) Establish background values, and enhancements
b) Enhancement fingerprint must conform to local O&G source

Won't discuss this part of the process today

Direct Outcomes: None – but improves and/or confirms target certainty

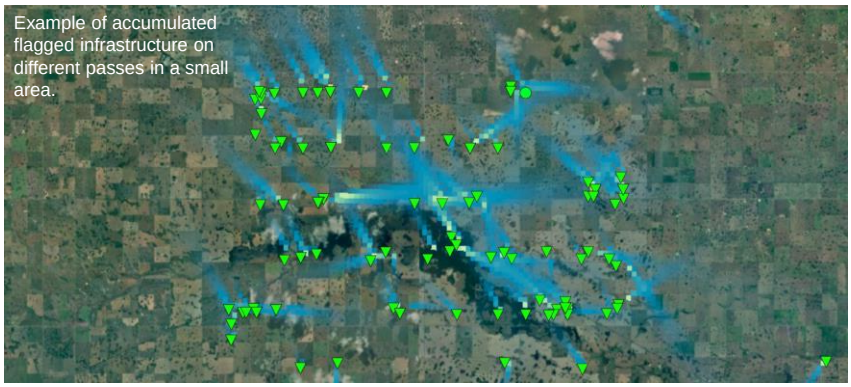
Methods

FLUX LAB gas detection measurement

Observations | Geochemistry | Quantification | Attribution

a) Conventional AERMOD-system screening level Gaussian Plume analysis
b) Estimate source strength (volumetric emission rate) for 1510 plume sources

Direct Outcomes: Emission severity profile. Over/under? Super-emitters?
Uncertainty: AERMOD screening has well understood errors. Averaging and statistical power increases confidence. Moderate to low.



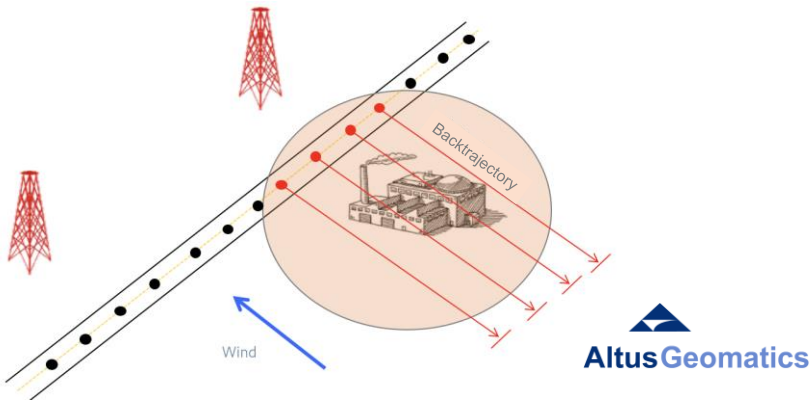
Methods

FLUX LAB gas detection measurement

Observations | Geochemistry | Quantification | Attribution

a) Map anomalies upwind to infrastructure within a reasonable distance
b) Same source must be flagged >50% of passes to count

Direct Outcomes: Emissions frequency/incidence. Patterns by age or owner?
Uncertainty: Low to High, by dev't. Megapads are an issue. Shadow sources.



Methods

FLUX LAB gas detection measurement

Observations | Geochemistry | Quantification | Attribution

Strengths and Limitations of the Approach

No methodology provides perfect information at all scales. Understand them.

Our limitations:
a) Can't point at the emitting component/gasket/vent.
b) Tall source "blackout zone" near base
c) Not ideal for total inventory – e.g. often ignore episodic emitters
d) Normally can't distinguish fugitives from vents

Our strengths:
a) Applicability at 100s m – real road-based oversight
b) Great for large-scale standardized comparisons, over/under screening
c) Statistically representative samples of developments
d) Efficient. As a single academic group we have covered a lot of ground.

How much overall? Mass balance → How much from what/whose? Mobile → What components? OGI

General campaign results

FLUX LAB gas detection measurement

Infrastructure sampled (downwind measurements):

	Montney	Peace	MedHat	Lloyd	Midale	Bakken	Total
Total	1576	497	1037	1058	1072	532	5772*
Wells	996	258	710	474	788	437	3663*
Facilities	610	239	327	584	284	95	2139*

*in almost triplicate

Incidence by development

Table: Fraction of total infrastructure emitting

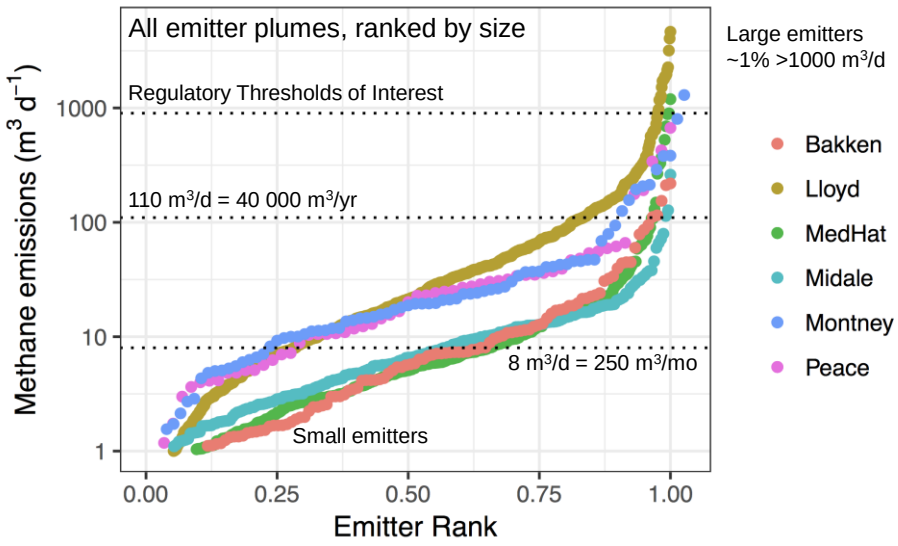
%	Montney	Peace	MedHat	Lloyd	Midale	Bakken
Emitting	29%	35%	40%	63%	47%	57%
Non-detect	71%	65%	60%	37%	53%	43%

Minimum Detection Limit is 1-10 m^3/d depending on conditions, distance

Volumetric rate estimates

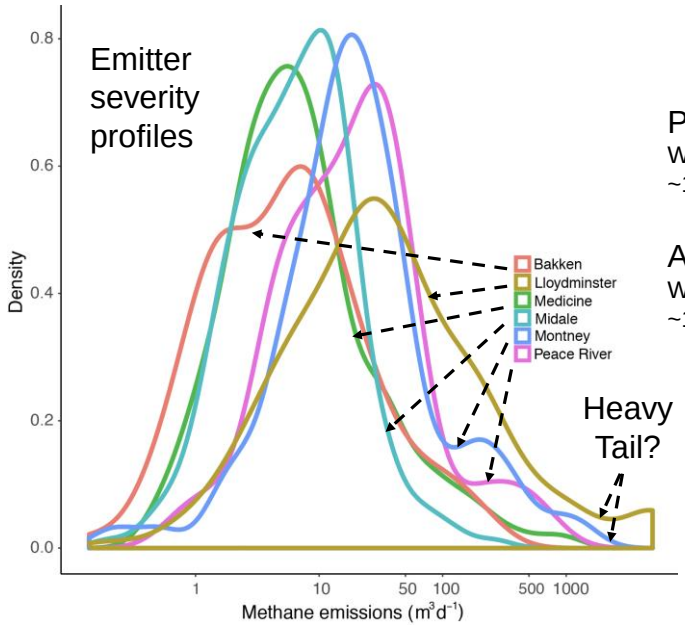
FLUX LAB gas detection measurement

Emitters (1512) and Regulatory Thresholds of Interest



Volumetric rate estimates

FLUX LAB gas detection measurement



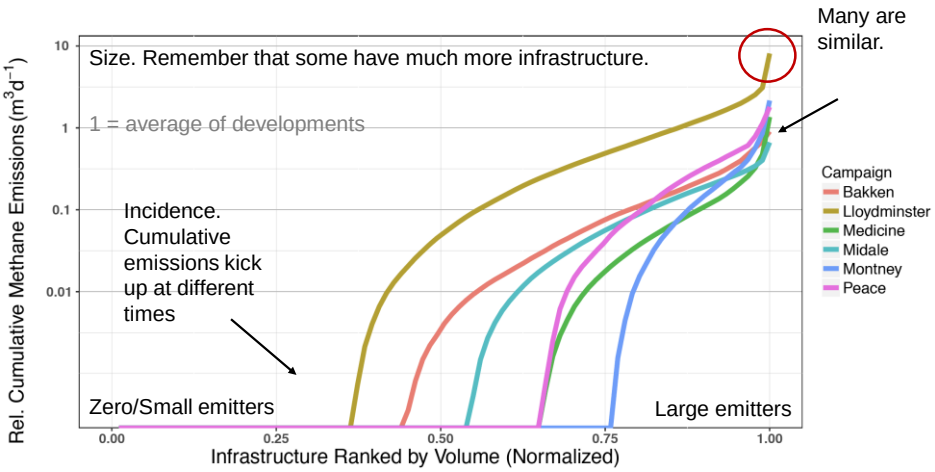
Peaks
Will reflect abundance
~10 to ~40 m³/d/src

Averages
Will reflect extremes
~10 to ~150 m³/d/src

← note log scale

Normalized emissions intensity

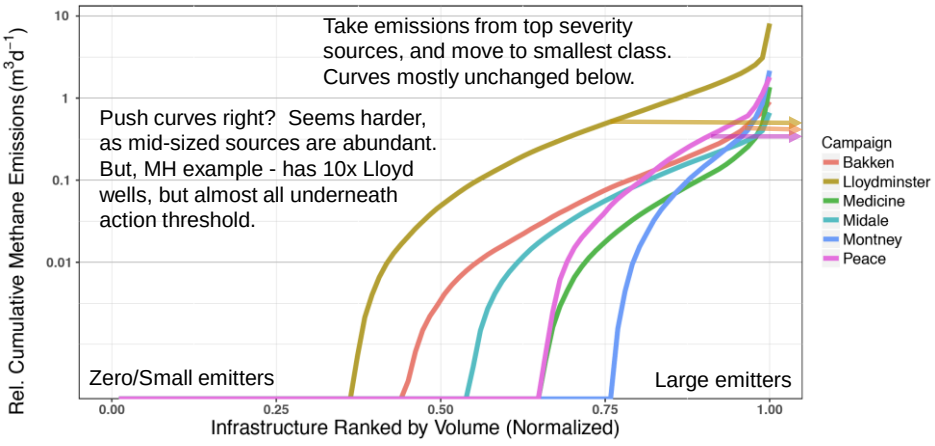
…per x pieces infrastructure. Combining frequency AND severity.



Lloydminster late kick shape? Few samples because these large emitters are relatively rare. Wish we had more. Large emitters are an important wildcard.

Normalized emissions intensity

Proposed regulation and emission curves?



Magnitude of gains will depend mainly on largest emitters. Hard to quantify.

Mitigation – Who, how much?

Development	CAPP	nonCAPP
Montney	100%	0%
Medicine Hat	54%	46%
Peace River	17%	83%
Lloydminster	72%	28%
Midale	17%	83%
Bakken	0%	100%
Average	43%	57%

Who was in the top 10?

- Non-CAPP operators were more likely to have sources in the top 10%
- But, CAPP operators were more active in developments that had higher emissions intensity

Over/under thresholds of interest: 8, 110, 900 m^3/d

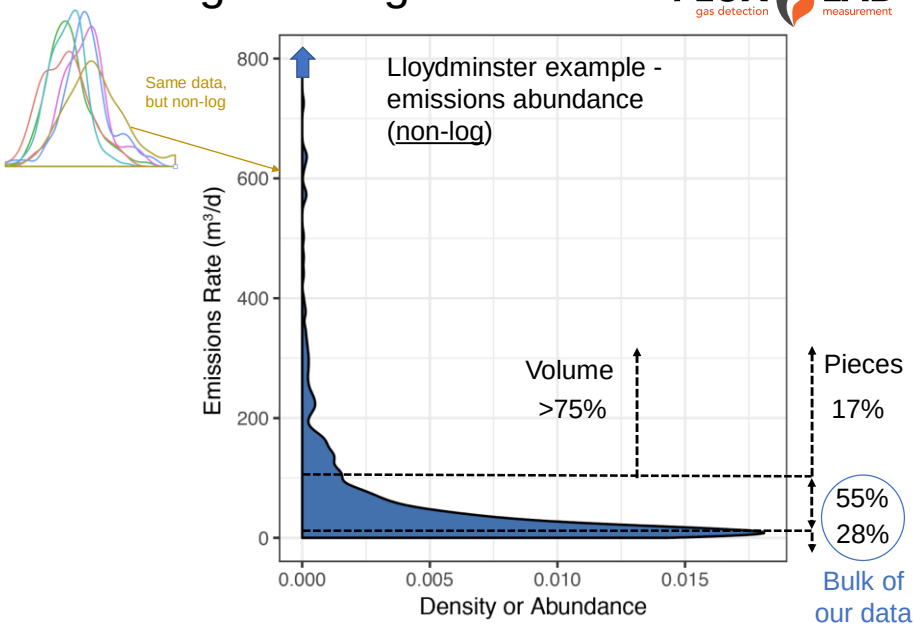
Estimated percent of TOTAL infrastructure

m^3/d	Montney	Peace	MedHat	Lloyd*	Midale	Bakken
Under 8	22%	28%	65%	28%	57%	63%
Over 110	13%	9%	3%	17%	1%	4%

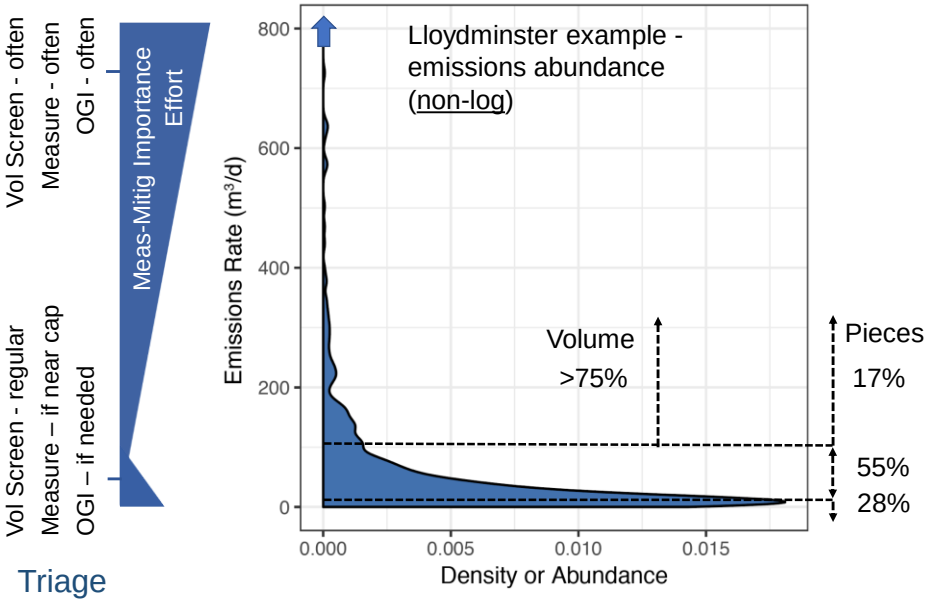
It is indeed possible to conform to 8 m^3/d. In fact, more <8 than >110.

*somewhat harder to estimate because of multi-well pads

Measuring for Mitigation



Measuring for Mitigation



Summary

Methane patterns in Canada

- Patterns of methane emission still emerging
  - >10-fold intensity difference across developments? Likely.
  - Inventories seem low
  - Some large emitters skew averages locally. Easy targets?
  - Proposed caps will target a relatively small portion of infrastructure
  - A good number of studies done in Canada
    - However, not much published. Data synthesis & sharing is a gap.

Remaining opportunities with our data

- Analyze remaining datasets
  - alt season Montney, Midale, Lloydminster
  - additional surveys Red Deer, another TBD
- Triage economics
- 3-D development-sized concentration maps for tech developers
  - Synthetic ground, air, satellite retrievals
- Work with others

Measurement perspectives

- Prone sources are worth measuring with greater intensity
  - Triage others, don't send every patient to surgery
- We'll need to measure in the regulated units (m^3/d)
  - Using dispersion toolbox from air monitoring regs would open doors
- Is the historic separation of vents and fugitives still valuable?