Based at St. Francis Xavier University, our research group focuses on gas measurement, geo-chemistry, tracers, sensor techniques, computation and data analysis. Our project funders and collaborators enable us to pursue worthwhile ecological and oil and gas research, and we sincerely thank you for your support! Please enjoy this compilation of highlights from 2019.

Dave Risk & Chelsie Hall
National Methane Baseline

In 2015 our research technicians and graduate students began criss-crossing Canada (and beyond) with high precision truck-based analyzers to conduct large-scale gas measurement campaigns. Fast forward three years, we have a repository of 6,500 site measurements at oil and gas wells, facilities, and other points of interest. As a small eastern university, this was no small challenge. We’re particularly proud to have created new contemporary pan-Canadian methane maps, viewable on our app website. We are most grateful to each of our project funders, collaborators, and our enthusiastic team for their contributions.

Significance and Impact

3 years of field data yielded high-impact, peer reviewed, timely publications by FluxLab members and alumni. In 2017 Emmaline Atherton, now Product Development Lead at spinoff company Arolytics, released a paper showing that almost half of the active well pads emit small amounts of methane. And that these sources cumulatively produce an overall inventory for the Montney exceeding provincial estimates - a controversial finding at the time - but which was recently confirmed by a follow-up study released in 2019 by the BC Oil and Gas Commission.
(cont'd) Significance and Impact

The following year articles were published by Elizabeth O’Connell and Jennifer Baillie, respectively. The first article authored by O’Connell, Arolytics president, documents characteristics of over 3,000 gas plumes the Flux-Lab team tracked down in three developments across Alberta and sourced to specific types of oil and gas infrastructure. The other study, by Altus GHG Emissions Monitoring Coordinator Jennifer Baillie, is similar but looks across southeastern Saskatchewan to compare the environmental performance of hydraulic fracturing operations co-located nearby conventional oil operations. Both studies show that emission levels are often higher than official inventories suggest. PhD student Katlyn MacKay recently published a case study paper on what we think might be the lowest methane intensity oilfield in Canada.

Recent published studies by our lab, Carleton University, EDF, industry, and regulators have sketched out a more accurate baseline for oil and gas methane. These new emission baselines came just in time; 2020 is the year of methane regulatory action in Canada, as a 45% decrease from current levels is sought. In 2020 and beyond we’ll be working to help industry adapt, and to track progress.
Methane Database Projects

Our lab group continues to collaborate with industry, provincial and federal government, and non-government organizations - in overlapping areas of science, policy, and advocacy. Right now, everyone is looking for methane data products and information as the federal methane regulations come into effect. **We have two special projects that address this need.**

Our xCanada Database of truck-based measurements originates from our lab’s mobile methane survey measurement database spanning 9 developments in BC, AB, and SK. This year we released our data publicly, in an online portal expertly built by Martin Lavoie. End users can use the map to view the measurements, view data products, or use query engines to extract the information they need. Super-users can also download the underlying measurements.

Our Methane Data Aggregation Initiative was part of the the **Fugitive Emission Management Program Effectiveness Assessment Study (FEMP-EA)**, a coordinated industry effort on methane emissions from the **Petroleum Technology Alliance of Canada and Canadian Association of Petroleum Producers**. For Alberta, we brought together our field data, and combined it with available data contributed by industry, government, academics, and NGOs, who generously supported the project. The aggregated datasets now comprise 7000 sites in Alberta alone, and are still growing in size through the support of the community. We have used these datasets to compare measurement technologies, to understand patterns of emission across geographies and infrastructure, and to build new data products and understanding.

In 2020 Martin, Katlyn, and Evelise Bourlon will be working to generate new data products and making them available - for updating inventories, for help in building Fugitive Emission Management Programs, and to help new technology developers. We will focus on sharing processed data products, to help everyone get answers to their questions with less work, and we can continue to incentivize new data sharing by protecting the measurements themselves.

Send us your questions if you think these aggregated databases could provide an answer. Or, if you want to send us your measurements, please inquire about the process, and the benefits of sharing.
Mobile Methane Detection

R&D Refining Truck-based Emissions Monitoring Techniques

With support from NSERC and Mitacs, we helped advance Altus Geomatics’ commercial truck-based methane measurement technology. No matter the scale of measurement, all emissions monitoring techniques involve uncertainty. We harvested large datasets from controlled gas releases over the last few years to better define measurement and calculation uncertainty, and to develop transparent performance metrics for use by our team and Altus customers. Lead: Jennifer Baillie, Jack Johnson, Kim Taylor

Reducing Uncertainty

Altus applies a transect-based air dispersion model to measurements, which helps them avoid lingering – and reduces wellpad screening times to under 3 minutes. In 2019, we performed computational experiments to define measurement uncertainties. The experiments help us paint a clearer picture of uncertainty, resulting in better dispersion algorithms, in-field work practices, accuracy, and transparent performance metrics. The partnership between Altus Geomatics-StFX-Mitacs will allow for continual improvements to the transect-based method over the next 2.5 years.

Quantifying Minimum Detection Limits

In the midst of the February freeze, we saw an opportunity to take our experiments indoors. With Atlantic Innovation Fund support, we used a large indoor space on the StFX campus to define the minimum detection limit of the Altus technique. Using industrial air blowers and a controlled climate, we created VERY small methane leaks which were sampled from as if in the field. The goal was to detect tiny emissions. From a distance of 10 m we were able to detect emissions 3 times smaller than Optical Gas Imaging Cameras are rated to detect under the best of circumstances in laboratory environments. This means that the two technologies can be used seamlessly in emissions measurement programs, complimenting each other at different scales of measurement. Lead: Jennifer Baillie, Jack Johnson
Marine surface water measurements

Methane in seawater indicates natural gas seepage from the sea floor, which may be of biologic (natural) or thermogenic (deep reservoir) origin. There is a lack of dissolved methane measurements which are useful for documenting regional patterns, identifying hotspots, and monitoring environmental impacts of the offshore oil and gas industry. We built a surface water measurement system to continuously map methane, carbon dioxide, and isotope signatures in surface waters offshore Atlantic Canada. After lab testing this winter, the maiden short-term deployment will be in local waters and this novel research area will be pursued in house and at Memorial University. Lead: Katlyn MacKay, Lesley James

Groundwater methane concentrations

Elevated groundwater methane concentrations are present in the coal-bearing Stellarton Basin. Six wells in our domestic wellwater sampling campaign had methane levels above the explosive hazard threshold (>28 mg/L), and atmospheric methane surveys indicated that methane was released to surface through backfill around infrastructure, and via tap outlets. We used isotopic fingerprinting to identify a mixed microbial-thermogenic methane origin in groundwater in this Natural Resources Canada-funded study. Isotopes and geochemistry of water and coal samples indicated there was aquifer interbedding with coals, as well as instances of gas migration. The dataset established in this study helps us establish a groundwater methane baseline, and understanding of sources. This could be useful if local coalbed-methane development continues. Lead: Kim Taylor, Owen Sherwood, Grant Wach

Winter measurements of gas release in northern ecosystems

This was the final year our custom-made low power monitoring stations recorded CO₂ emissions year-round in our Arctic soil gas observational network funded by The National Aeronautics and Space Administration (NASA) under the Arctic Boreal Vulnerability Experiment, in conjunction with Sue Natali at Woods Hole Research Centre. The study resulted in a Nature publication which shows measurements from 100 sites around the polar arctic reveal much more CO₂ is being released in the winter, due to warmer soils, than previously thought. 3 FluxLabers are among the 75 authors from 12 different countries. **Lead: Dave Risk, Meghan Flood**

Methane in the Mackenzie Beaufort Delta

Operating from the Aurora Research Institute in both the summer and fall, we completed an extensive 4-week campaign sampling remote natural methane emission hotspots by helicopter and truck (of course!), and also piloted boat based mobile surveys in the Mackenzie River Delta. With support of the Geological Survey of Canada and NSERC Discovery, our two campaigns revealed some of the largest hotspots were produced in the active layer of the permafrost while others were geologic seeps. This data will help us better understand methane production in arctic landscapes where relevant data is limited. **Lead: Daniel Wesley, Isaac Ketchum, Scott Dallimore**
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**Agriculture Soil Gas Emissions Projects**

**Mooo**

Commercial livestock creates substantial greenhouse gas emissions. In agriculture-dense areas of Nova Scotian we began collecting mobile soil gas measurements of methane and carbon dioxide emissions from livestock sources to better understand emissions of farms and regional patterns. Our large-scale monitoring expertise in energy developments transfers well into this space. Agriculture is another big target for methane reduction. **Lead: Sarah Kennedy**

**Surveying development for off highway vehicles and boats**

We equipped an ATV for mobile surveying with support from Altus Geomatics. Measuring wind accurately in the complex terrain accessible by ATVs is a first step to measure greenhouse gasses in these areas. This year we did experiments comparing stationary and ATV anemometer measurements so that we could refine hardware design and data processing – ultimately to improve the quality of wind measurements. This work will enable us to measure both natural and manmade sources of greenhouse gas emissions in areas not accessible by roads, like agricultural sites. A Hewescraft boat was also equipped this summer in the Arctic sea for mobile surveying in shallow waters. **Lead: Daniel Wesley, Sue Ziegler**
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Lead: Jennifer Baillie, Jack Johnson

Lift off

ISS Aerospace, based in the UK, reached out to the FluxLab for help measuring gases by drone across large oil and gas developments. We custom built two lightweight high-precision sulfur dioxide and hydrogen sulphide sensors, controlled by a microcomputer. The sensors were designed to mount on ISS’s long-range drones for the mapping work. During overseas campaigns the sensors provided impressive data and we’re now involved in data analysis. We look forward to continued collaborations with ISS in future research projects.

Lead: Isaac Ketchum

Verifying satellite sensors

Measuring methane from satellites has many advantages, including spatial coverage that is superior to all other methane monitoring techniques. We worked with Bluefield Technologies Inc to provide a third-party assessment of their satellite-based methane sensor. Extensive controlled release experiments were conducted outside of Quebec City. Our testing helped Bluefield understand their sensor’s detection abilities under different atmospheric conditions. Both ground-based and aerial (helicopter) blind testing was part of this work. For us this project was an exciting opportunity to help in satellite development, and to see Bluefield’s cutting-edge technology in action.

Lead: Katlyn MacKay, Dan Wesley

Atmospheric transport models

We employ advanced computational techniques to develop existing atmospheric transport models as a data analysis tool. By applying different approaches of one of the most widespread models called Footprint, we can track back emissions to their sources upwind of the location of measurements, even in complex terrains. This method helps us understand the role of land structure and atmospheric conditions in flux exchange between sources and sinks and enables us to find unknown sources of emissions in a 2-dimensional pattern.

Lead: Afshan Khaleghi, Lesley James
Aquistore soil gas monitoring

We continued our soil gas sampling work at Aquistore, as part of a comprehensive monitoring system for this Carbon Capture and Storage research site at the Boundary Dam power plant in Saskatchewan. Our soil gas sampling program is used to establish the presence of surface effects from the project. As expected, we’ve not seen any. In 2019 we visited Aquistore twice but sadly, we missed catching up with our collaborators at the Petroleum Technology Research Centre’s annual Aquistore General Meeting. We look forward to attending next year and our continued involvement in this important long-term project. **Lead: Rachel Lewis, Sara Murrin, Kim Taylor**

Shale gas risk assessments in the UK

We’re excited to be part of a British Geological Survey project called EQUIPT4RISK. Awarded as part of the £8 million Natural Environment Research Council research program on unconventional hydrocarbons in the UK, this project is investigating surface and near-surface processes that affect pollutant behaviour in water and air, and earthquake hazard associated with shale gas development in the UK, with an eye towards cumulative, long-term, and regional effects. **Lead: Dave Risk**

Eosense, University of Windsor, and measurement projects

Identifying gas migration from leaking production and abandoned wells is a challenge. To understand and improve measurement methodologies, we were involved in running computer simulations and field measurement campaigns near Brooks, Alberta. Modeling results demonstrate that in-soil concentrations provide limited insight related to soil gas flow rates and volumes, whereas surface flux chambers could be more accurate. Field studies demonstrate the same, and of course field patterns are more complicated than in the virtual world. We’re rising to the challenge! **Lead: Rachel Lewis**
Lab Bench to Market

It’s not enough to develop interesting technologies, knowledge, or expertise. When we have something useful for the world, it’s our responsibility to help it deliver. We’re not afraid to roll up our sleeves and step outside academia!

Strengthening our partnership with Altus Geomatics

Altus Group and StFX have a technology collaboration agreement to improve truck-based methane detection. The Altus technology originated in the FluxLab, but Altus deploys it commercially to serve O&G clients. We provide technology support, and in 2019 our collaborations were in the area of data analytics. FluxLab alumni Jennifer Baillie, now Altus GHG Emissions Monitoring Coordinator, worked on these projects with two lab interns, under a Mitacs internship program. Their work benefits current and future clients.

Arolytics gains momentum

This young Halifax- and Calgary-based startup, co-founded by Liz O’Connell, Emmaline Atherton, and Dave Risk grew its client base significantly, won competitive awards like Innovacorp Accelerate Program and Volta Cohort, and is advancing through the Creative Destruction Lab program in Calgary. Arolytics was founded on expertise, and in response to industry needs around methane reduction programs. The company helps industry plan and execute cost-effective fugitive leak detection programs, and AROviz online software helps companies manage emission measurement data, track repairs, generate regulatory compliance reports and analytics.

Eosense expands to gas migration tools

Launched as a startup from this lab a decade ago and based in Dartmouth, Eosense is one of the main providers worldwide for scientific soil gas measurement hardware. With help from the Natural Sciences and Engineering Research Council, we are working with Eosense to develop new low-cost in-situ gas detection analyzers for applications in oil and gas. We are also working extensively on projects to improve measurement of Gas Migration. Over the past decade, FluxLab has continued to provide Eosense with science, and skilled new staff.
In closing

We are appreciative of our many valuable project partners and funders in 2019, including those unnamed in this newsletter. And we are incredibly grateful for our dynamic team, past and present, who collectively raise the bar and push our research further.

We value your continued support. Our team of researchers at St. Francis Xavier University looks forward to working with you in 2020!

Dave Risk PhD (Team Lead)
Chelsie Hall BA BEd (Projects Manager)
www.fluxlab.ca / www.stfx.ca