PROJECT OVERVIEW

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EXECUTIVE SUMMARY

Altus Geomatics provided it's ExACT emissions monitoring service to the PTAC Alberta Methane Field Challenge (AMFC). Over 9 field days, we conducted 136 ExACT surveys at 51 target facilities near Rocky Mountain House, Alberta. We were able to survey an average of 15 sites per day with the ExACT truck. We calculated the average facility-level emission of the sites to be 58.2 $m^3 CH_4$/day. Data was provided to the research team for analysis and comparison to other alternative monitoring technologies and Optical Gas Imaging cameras (OGI).

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BACKGROUND AND OBJECTIVES

Alberta is the highest greenhouse gas emitting province in Canada with the oil and gas sector being responsible for 48% of emissions (National Energy Board, 2019). Methane is a greenhouse gas with a radiative heating potential 28 times that of carbon dioxide over a 100-year timespan. It is estimated that methane emissions from the Alberta oil and gas industry reached nearly 80 megatonnes per year, 3.5 megatonnes of which was attributed to methane leakage from oil and gas wells. In November 2015, the Government of Alberta introduced the Climate Leadership Plan (CLP) with the aim to reduce methane emissions from upstream oil and gas production by 45 percent from 2014 levels by 2025 (Alberta Climate Leadership Plan, 2018).

Despite recent industry incentives and government policies announced to have emission reduction regulations by 2020, implementing these reductions efficiently remains a challenge. Emission monitoring, leak detection and repair is often time consuming and costly. Alberta Directive 060 will allow alternative technologies to be used in place of OGI cameras or Method 21 for fugitive emissions surveys if they are deemed equivalent to the prescribed technology. To help evaluate alternative methane sensing technologies, the Alberta Methane Field Challenge (AMFC) was launched through the Alberta Upstream Petroleum Research Fund (AUPRF). The aim of this challenge is to assess the real-world performance of new methane sensing technologies in comparison with conventional optical gas imaging-based leak detection surveys. Operators and regulators in Canada are interested in new technologies that can deliver cost-effective methane emission detection and quantification compared to conventional approaches.

TECHNOLOGY DESCRIPTION

At Altus Geomatics, we use vehicle-based technology referred to as ExACT (Emissions Attribution via Computational Techniques) to collect multi-gas measurements to identify and attribute emissions to specific sources algorithmically at the site or facility-level. The ExACT surveys are conducted by driving in triplicate passes on or nearby a facility to intersect an emission plume downwind, as illustrated in Figure 1.

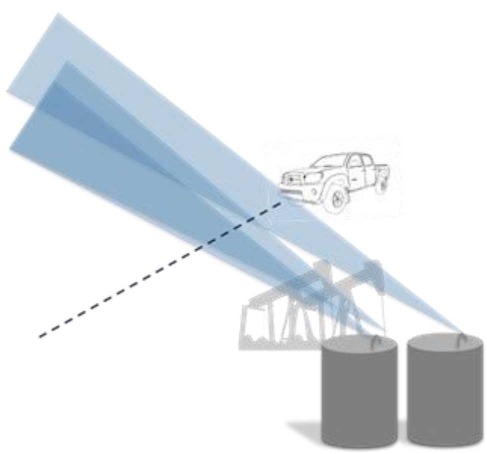

Figure 1. An idealized illustration of the ExACT vehicle intersecting a plume downwind of the source.

The ExACT technology is an innovative solution that offers a competitive advantage over other gas detection technologies as it can cover more area and detect super-emitters quickly. With ExACT technology, industry can easily identify which sites need to undergo repairs to reduce net emissions and meet targets. The technology does not discriminate fugitive emissions from leaks but can highlight sites where the net emissions may be nearing regulatory limits. As 70% of methane in Alberta is generated by the energy industry (Government of Alberta, 2019), the ExACT technology has the potential to assist Alberta and Canada meet greenhouse gas reduction commitments.

The ExACT method, detailed in Baillie et al. (2019), utilizes a truck-based system that collects gas concentration, location, wind and atmospheric stability data once a second while driving. ExACT can measure up to one hundred sites daily, depending on site density and terrain. Survey operators can remain inside of the vehicle during the entire survey, which allows for easy site access and safety protocol compliance. ExACT and the instruments used can be operated autonomously and are powered by onboard continuously charged batteries, allowing the driver and assistant to focus on safety, navigation and efficiency. The method provides real-time feedback, which can prompt the driver or assistant to target high emission sites and areas for same-survey follow up.

Collected data is then processed using patented algorithms and applied to an inverse Gaussian plume dispersion (GPD) model, outputting volumetric emission rate estimates per-facility. As with most inverse GPD applications, there is expected uncertainty that classifies emission rate quantification calculations as estimates. Current uncertainty within a standard three measurement (triplicate drive-by) emission rate estimation is 63%, with a slight bias to underestimate (O'Connell et al., 2019). However, this level of uncertainty is comparable to similar alternative method, EPA OTM33a, which calculates emission rate within 60% accuracy, using lengthy (15-20 minute) stationary measurements (US EPA Air Quality Assessment Division, 2018).

FIELD SUMMARY

As part of the AMFC, Altus targeted 50 site locations of various facility sub-types near Rocky Mountain House, AB from June 11 to June 19, 2019. On site, we completed at least 3 loops or downwind transects of the infrastructure. While surveying, the field assistant noted the number and types of equipment such as wellheads, tanks and separators on site, while gas concentration, GPS and ambient weather data were all logged to a central device automatically. As well, we identified one non-target site (gas plant) that we consistently measured from the road, which we added to our results. Including repeat measurements, we completed 136 surveys of the 51 sites to quantify site-level emissions. Of the sites visited, 100 had quantifiable emissions, 26 had no emissions and 10 were inconclusive as we were unable to quantify emissions due to accessibility issues or wind direction.

The ExACT method is extremely efficient, with on-site surveys of sites taking generally 5-10 minutes to complete once on site. The density of the sites was low, with only approximately 1.5 sites per 100 km^2 in the study region. Although travel time between sites was significant, we were able to reach an average of 15 sites per day, up to a maximum of 23 in the regions with the highest density. Table 1 breaks down the number of sites visited on each survey day.

Table 1. A breakdown of the number of sites visited, emitting, not emitting and unable to get downwind of on each survey day.

Survey Date	No. sites visited	No. sites emitting	No. sites not emitting	No. sites unable to get downwind
Jun-11-19	9	8	1	0
Jun-12-19	13	12	1	0
Jun-13-19	10	8	2	0
Jun-14-19	14	10	3	1
Jun-15-19	12	10	2	0
Jun-16-19	16	11	5	0
Jun-17-19	22	13	4	5
Jun-18-19	17	14	2	1

Jun-19-19	23	14	6	3
Total	**136**	**100**	**26**	**10**

We calculated the average facility level emission of the emitting sites to be 58.2 m^3CH_4/day with a range of 0.2 to 3123.2 m^3CH_4/day. Most sites had extremely small emissions, with only seven measurements estimated over 100.0 m^3CH_4/day, with two of those measurements coming from the additional gas plant added. The distribution of median emission rate estimates is shown in Figure 2.

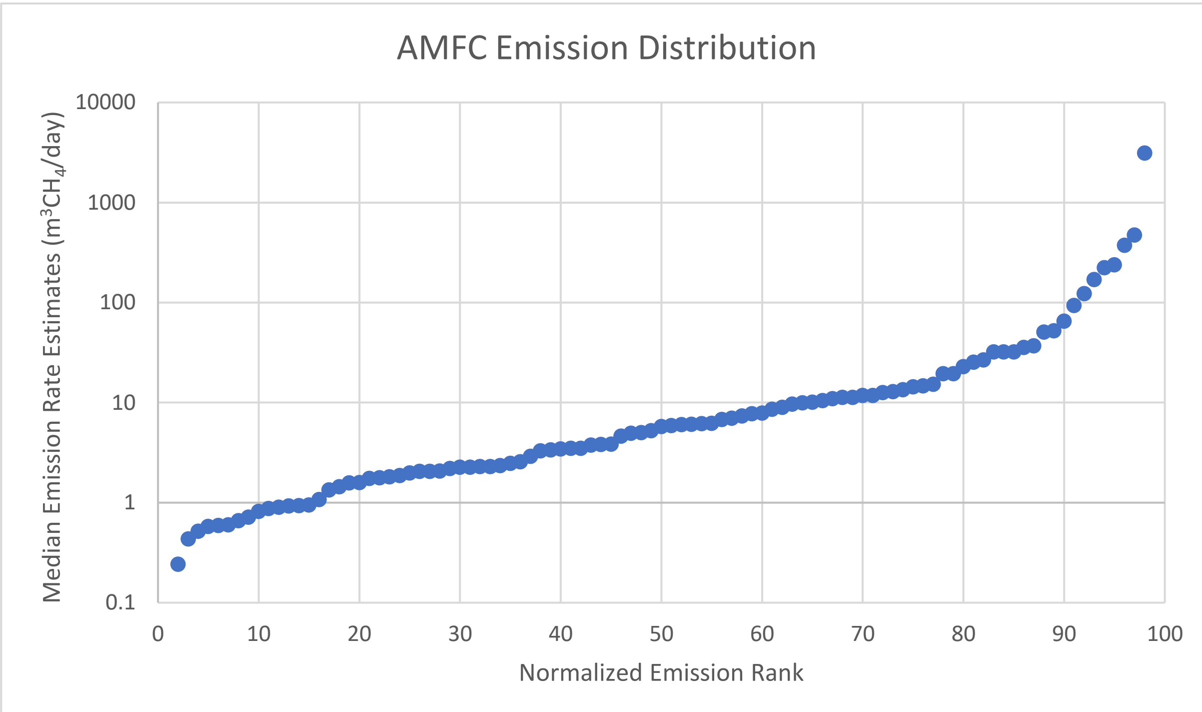

Figure 2. Median emission rate calculation for each emission survey completed. Emissions sorted by normalized rank. (Please note the logarithmic scale on the y-axis.)

The weather conditions during the study were fair, with days of heavy rainfall and thunderstorms. We were not negatively impacted by the weather during our participation and were able to monitor continuously. Although, due to rainy conditions some of the access road conditions were poor, but we were able to safely access and obtain measurements of most sites.

LEARNINGS AND AREAS OF IMPROVEMENT

Infrastructure Geolocations:

Complete and accurate infrastructure location files are vital to the ExACT process. The attribution and quantification calculations are highly sensitive to missing or incorrect infrastructure location data. Infrastructure location errors as small as 1-5 meters can impact emission rate quantification results by 3-4 orders of magnitude (i.e. 1,000,000 m^3CH_4/day instead of 100 m^3CH_4/day). By using updated and accurate geolocation data, provided by regulators or operators, rather than estimated locations, we can improve the accuracy of ExACT's emission attribution and quantification.

Additionally, the capabilities of vehicle-based technologies that use continuous-monitoring sensors, like ExACT, can be maximized by providing additional geolocations of proximal sites or all sites within a target development. Currently, any gas data collected from sites without geolocation data is not considered, as the plume dispersion model requires an input for the source location. However, the gas concentration data is retained in the raw files, giving us the ability to reprocess pre-existing survey data if it becomes available in the future and can attribute these plumes to sources that were not initially available.

Emission Source Height:

On-pad and close-proximity measurements of sites with infrastructure of significantly varying heights can create potentially over-inflated emission rate estimates. This is due to close-proximity measurements being outside of the typical assumed geometry of the Inverse GPD model used by many vehicle-based measurement techniques. Some sources are too tall to be picked up by close-proximity measurements and will be better measured using ExACT at distance. To date, manual analysis is done on a case by case bases to include only infrastructure pieces that are within the appropriate measurement area when quantifying a sites emission rate. Such analysis prevents improper quantification and may be combined with measurements at greater distances for whole site measurements. Altus is actively building analysis tools into ExACT’s automated scripts as a form of quality assurance.

Gaussian Plume Dispersion Model Parametric QA/QC:

Altus is in the process of conducting a parametric sensitivity analysis on the GPD model used in ExACT. The findings of this analysis will reveal measurement parameters (wind speed, stability class, etc.) that are highly sensitive to measurement conditions and temporal variance. The results will be a key tool in furthering the quality of ExACT’s outputs, by improving data quality indicators used for quality assurance and control at the data processing stage.

COST IMPLICATIONS

When evaluating our costs, we looked at the pre-planning, field and post-processing costs of the project. Our pre-planning costs were low, as expected, as site access and schedules were pre-arranged. This project highlighted that we have a high level of confidence in our field pricing and the time it takes to execute field work. From this project, we foresee the possibility of additional costs in data processing and reporting.

The amount and quality of infrastructure data available is an important factor impacting post-processing cost. Where we have comprehensive information about the facilities, equipment and their geolocations, Altus can provide not only more comprehensive, accurate data product, but it can be prepared more rapidly. Where data is lacking, the quality infrastructure source files may be compromised, necessitating additional data collection and manual adjustments, which is time consuming and costly. Obtaining current, complete and accurate infrastructure databases is a challenge faced by operators, regulators and emissions monitoring service providers alike. We will consider the additional time and cost to deal with infrastructure files in future projects.

Flexibility is an important factor in the implementation of any new approach or procedure. Where some of the data deliverables for the AMFC were outside our usual scope, such as distance to source, weather conditions, etc., more time was required for post-processing and data entry than initially expected. However, there is ongoing work to integrate these data products into our commercial deliverable to provide necessary data to clients and regulators. Once those additional data products are integrated into our processing and reporting procedure, these additions would not add any additional costs to a project as the information is currently being recorded during the ExACT survey.

DATA PRODUCT EXAMPLE

ExACT is offered as a technology-as-service product. We provide products which are tailored to client needs and may vary from client-to-client. ExACT survey products include volumetric methane emission rates (m^3CH_4/day) on a per-facility basis, accompanied by key information such as monitoring time, UWI, Facility ID code, latitude, longitude and operator information tied to each measurement.

Figure 3 is an example of the data interactive report produced by ExACT. Producers can view survey routes driven by the ExACT truck, methane heat maps to visualize hot spots and graphs of emissions. All tables can be downloaded for record keeping and reporting. Using the emission rate estimates we can highlight sites which may be exceeding regulatory limits, need follow up, or are compliant. We can also include information on sites that are not emitting, maximum above-ambient concentration enhancement of CH_4, distance to emission source and weather conditions at the time of monitoring.

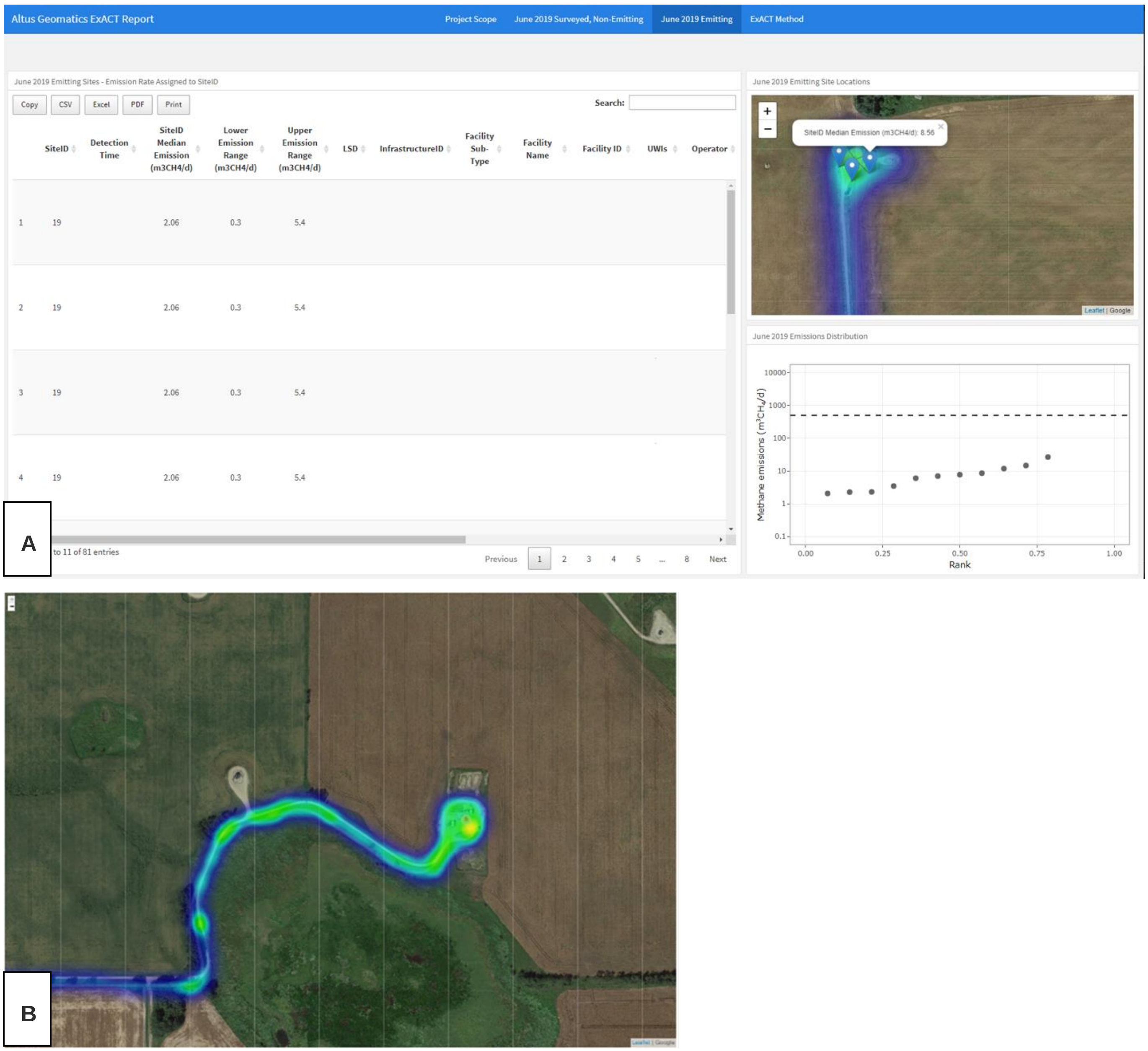

Figure 3. ExACT interactive report example. (A) Displays the table on the emitting sites, heat map and emissions distribution graph. (B) Is a zoomed in image of a heat map displaying methane relative methane concentrations on site.

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