Estimating Fugitive Methane Emissions from Metering and Regulating Stations in Ohio, U.S.

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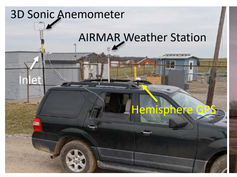
Introduction

Transmission Distribution Transfer Stations (TDTS), a.k.a City Gates, are the Metering and Regulating (M&R) Stations at which the custody of Natural Gas (NG) changes from the transmission company to a local distribution company. According to the EPA GHG inventory, the M&R stations contribute about 9% of methane emissions in the NG distribution and are categorized as per the pressure of natural gas in the pipeline. In our literature review, we determined that the current emission factors developed for the distribution sector do not account for seasonal variability.

In this study, we seek to calculate emission rates for the TDTS by exercising EPA Other Test Method (OTM) 33A. This study was conducted in the state of Ohio during winter and utilized a external data provider to identify the M&R stations. There are about 123,000 M&R stations in the United Stations according to the recent GHGI.

Methods

The EPA OTM 33A system consists of a Concentration Measurement Instrument (CMI), 3D Ultrasonic Anemometer, Weather Station and High-Resolution GPS. The system is mounted on a sport utility vehicle which is parked downwind of the source for a brief period to collect stationary measurement data. The CMI used for this study is an LGR Ultraportable Greenhouse Gas Analyzer which provides near real-time ambient air methane concentration in ppm. The data was collected at 2 Hz frequency from every instrument and logged (time aligned) using Mobile Emissions Monitoring software provided by EPA. This method assumes the methane plume to be a Gaussian distribution from a point source in which the wind direction, wind speed and distance to the source play a crucial role in determining the emission rate. We used an Infrared camera (FLIR) and Pergam Laser Methane Copter (LMC) sensor to identify the potential leak points at each M&R facility.



The post processing of data was done using python and the emission rates were calculated using a program provided by EPA. In theory, the data collected represent the emission rate from a point source. However, the TDTSs surveyed could have multiple leaking components. Due to variation in wind direction during sample collection, the sampling mast mounted on the vehicle collected the data from multiple sources within the station, if present, and thus provided a whole-facility fugitive emission rate if not from a single component.

Measurements

Two weeks of measurements were conducted at 12 sites in Ohio during the month of December. The sites were selected randomly using an external energy infrastructure data provider (Rextag). Limited information was available for each station before the visit, but the locations were identified to be city gates from the Rextag database. Stationary data collection was performed for the sites emitting methane above background concentrations.

Current U.S. EPA GHG Inventory

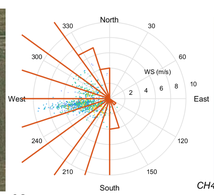
- The current EPA inventory categorizes the M&R stations into 10 types comprising M&R stations and pressure regulators.

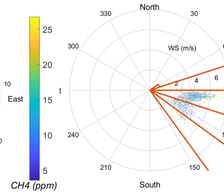
Category	Activity Data (stations)	Emission Factor (kg/station)	Emissions in kt (Recent Inventory)	Sample Size	Year Based
M&R (>300psi)	4008	2142.7	8.6	59	2015
M&R (100-300psi)	14627	995.4	14.6	10	2015
M&R (<100psi)	7818	727.2	5.7	3	1996

- The pressure regulators (also called as District Regulators) are either vaulted or above ground and classified in the inventory as : Reg (>300 psi), R-Vault (>300psi), Reg (100-300psi), R-Vault (100-300psi), Reg (40-100psi), R-Vault (40-100psi) and Reg (<40psi).

Source Characterization

Site - 06



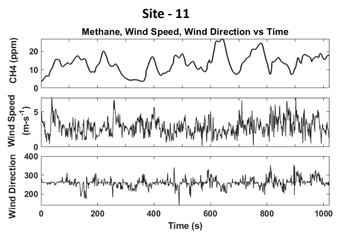


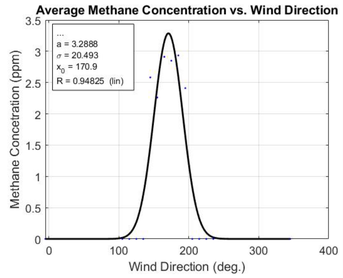
Site - 11

- In general, the M&R stations are comprised of meters, pressure regulators, pneumatic valves and vents, flanges, line heaters and catalytic heaters.
- The key difference between a city gate and a normal M&R station is that the city gates have an odorizer which is added to the natural gas before sending it to the distribution mains.

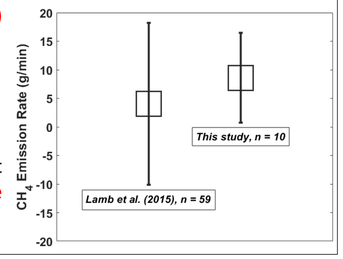
Methane Emissions Estimation

Site ID	Max CH4 (ppm)	Wind Direction Std. Dev.	Emission Rate (g/min)
1	5.52	11.24	3.48
2	10.25	29.97	7.37
3	3.56	9.13	1.68
4	24.71	23.53	237.54
5	4.05	24.91	4.1
6	26.77	22.39	341.54
7	8.16	15.96	9.82
8	5.55	19.99	27.45
9	6.78	20.79	5.65
10	5.15	15.78	9.38
11	13.8	9.86	15.4
12	3.19	17.83	1.5

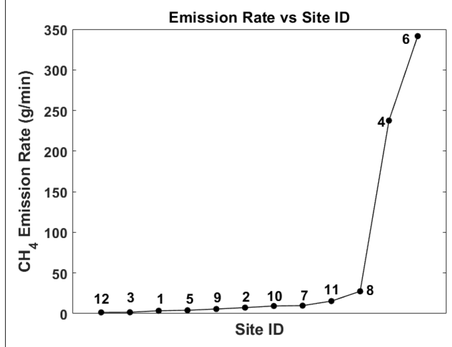


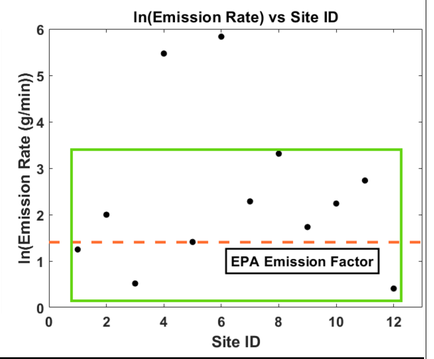


- As per GHGI, the emission factor for M&R (>300psi) is 4.06 g/min. [1]
- No two sources are identical.
- $G = a \times \iint exp - \left(\frac{y^2}{2\sigma_y^2} + \frac{z^2}{2\sigma_z^2}\right) = 2\pi \times a \times \sigma_y \times \sigma_z$
- $Emission\ Rate = G \times Wind\ Speed$ [2][3]
- Outliers are a concern: 2 of the 12 sites exhibited fat tailed distribution. 87% of the total emissions came from sites 4 and 6.



Initial Conclusions





Comparison	Lamb, 2015	This Study
Sample size, n	59	10
Emission Rate Mean (g/min)	4.06	8.58
Standard Deviation (g/min)	14.15	7.88
95% UCL (g/min)	7.67	16.46

- Based on the data collected, the pressure regulators and pneumatics vents appear to be sources of significant contribution.
- The emission rate calculated using EPA OTM 33A are within the range of uncertainties in EPA estimates.

Future Work

- The emission factors for the M&R stations used in the GHGI were developed based on studies conducted in Summer/Fall. So little information is available about variations in methane emissions in Summer and Winter and thus opens an opportunity for future research.
- The importance of fat tail distributions needs to be recognized and addressed to have a more precise inventory on methane emissions from NG distribution.
- The emission factor for M&R (100-300psi) is calculated based on a sample size 10 which seems to be under sampled and needs further attention.
- Partnership with the local distribution companies is essential in terms of geographical distribution, obtaining facility addresses and access to compare component-level emissions measurements with the vehicle-based whole-facility measurements.

References

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