Atmospheric Gas Concentrations During an Unconventional Oil and Gas Recovery Operation at the MSEEL Test Site, West Virginia*

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Abstract

The Marcellus Shale Energy and Environment Laboratory (MSEEL) in West Virginia provides a unique opportunity in the field of unconventional energy research. By studying near-surface atmospheric chemistry over several phases of a hydraulic fracturing event, the project will help evaluate the impact of current practices, as well as new techniques and mitigation technologies. A total of 10 mobile surveys were conducted around the MSEEL site that contains 3 test wells (1 science well and 2 natural gas producing wells) and over several miles of nearby regional routes. Our surveying technique involved using a vehicle-mounted Los Gatos Research Ultraportable Methane/Acetylene Analyzer that provided geo-located measurements of methane (CH₄) and carbon dioxide (CO₂). The ratios of super-ambient concentrations of CO₂ and CH₄ were used to separate drilling- and fracturing-related observations from the natural background concentrations over the various well pad developmental stages. We found that regional background methane concentrations were elevated in all surveys, with a mean concentration of 2.699ppm (n = 98369), which simply reflected the mix of anthropogenic and natural CH₄ sources in this riverine urban location. Over time and through successive stages of well development, we noted a progressive rise in the occurrence of enriched methane in the vicinity of the developed wells. While there was a moderate degree of variability over time, we did observe a higher occurrence of CH₄-enriched observations during and after production began at the test site (~25% of measurements within 500 meters of the test wells) compared to the baseline surveys (>10% of measurements). This change was expected, as we anticipated some level of increased emissions from the well pads as production began. However, we did not expect the rise to be so noticeable. The results of this study show that there is a statistically significant increase in the occurrence of enriched methane values in the vicinity of the well locations when we compare pre-production to postproduction surveys, and that pre-existing methane sources in the immediate vicinity must be accounted for when assessing environmental impacts.
Reference Cited

ATMOSPHERIC GAS CONCENTRATIONS DURING AN UNCONVENTIONAL OIL AND GAS RECOVERY OPERATION AT THE MSEEL TEST SITE, WEST VIRGINIA

Introduction

The Marcellus Shale Energy and Environment Laboratory (MSEEL) in West Virginia provides a unique opportunity to measure the effects of hydraulic fracturing in an urban environment. The site consists of 2 producing wells and one scientific subsurface data (right).

In this study, we seek to analyze atmospheric gas measurements and observe temporal and spatial trends at the MSEEL site utilizing a mobile surveying approach. We hypothesize that the MSEEL site will be associated with episodic emissions, with peaks at flowback and sustained emissions through production. We also suspect that MSEEL emissions can be detected above the natural and urban variations.

Methods

The mobile surveying method consists of a vehicle-mounted LGR Ultra-Portable Methane/Acetylene analyzer. Tubing runs from the front of the vehicle to the analyzer located in the cab. Atmospheric gases were sampled for CO, CO₂, and CH₄ at a 1 Hz frequency. A total of 10 mobile surveys were performed from July 26th to December 30th, 2015, for a total amount of 99,376 geo-located data points. The general survey route relative to the MSEEL site is outlined in the figure to the left. A timeline of all hydraulic fracturing events is illustrated in the right figure.

Volume Quantification of Flowback

- Volume output of CH₄ during flowback was estimated from largest observable downwind plume during flowback (right figure) via inverse Gaussian Plume Dispersion model.
- Output was estimated at 10283.3 (+ /- 869.2) g/min CH₄ during largest flowback plume.
- Relatable study by Allen et al. (2015) saw flowback volume output ranging from 2970 g/min to 5 g/min CH₄.

MSEEL Emissions

- Methane emissions from the MSEEL site varied over the 10 surveys, but showed distinct peaks during flowback (top figure).
- Drilling emissions were episodic, and ranged from nearly non-existent to mildly above ambient levels.
- Depletions in excess CO₂ and CH₄ below 200 are indicative of a CH₄ concentration more than 4 times that of the natural atmosphere.
- Flowback showed a significant density peak in excess CO₂ and CH₄, approaching 0, which is highly enriched in CH₄ relative to the natural atmosphere.
- Southward winds for Survey 6 and 7, Northward winds for Survey 8-10.
- Data was filtered for excess CO₂, excess CH₄, and CO₂ concentration more than 4 times that of the natural atmosphere.
- Sporadic plumes are evident throughout the surveys.
- Density plumes in the MSEEL vicinity are consistent throughout Surveys 6-10.
- The greatest density peak is observed during flowback (Survey 9).

MSEEL Within Urban Complexity

- We binned data spatially (Figure A), and plotted the occurrences of rejected null hypothesis for both CO₂ and CO₂ via Tukey HSD test (Figure B).
- The MSEEL cell was one of 6 associated with significantly elevated CH₄ concentrations.
- Cells characterized as urban environments were predominantly associated with elevated CO₂ concentrations.
- MSEEL emissions will continue during production.
- MSEEL site continues to be used in studies spanning a variety of scientific disciplines.
- Future work will likely involve more intensive surveys exploring CH₄ emissions.

Future Work

- Environment such as Morgantown present challenges for CH₄ source attribution.
- There are a number of potential CH₄ sources that exist in this riverine urban location, both from natural (e.g. Monongahela River) and anthropogenic sources (e.g. sewage treatment plants).
- The elevated CH₄ concentrations observed throughout the surveys suggest that there may be large regional CH₄ contributions from various sources within the Morgantown region.
- The largest CH₄ concentrations were detected near a flooded storm drain in grid 17 (over 300 ppm CH₄).

Special Thanks

We’d like to thank the MSEEL and associated parties for the opportunity to perform this research, and for the help and guidance along the way. We’d strongly recommend visiting her website for more information on related research, as well as for additional background info: mseel.org

References


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