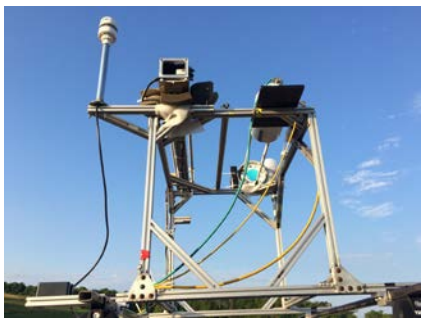
Variation in Methane Emissions from Natural Gas Well pads in the Marcellus Shale Region

Tanvir Mangat[1], Dana Caulton[2], Mark A. Zondlo[2]
[1] University of Massachusetts Amherst, Amherst, MA 01003, USA
[2] Princeton University, Princeton, NJ 08544, USA

Due to technological advancements in extraction processes and an abundance of naturally occurring reserves, the natural gas production has seen an increasingly rapid boom in a short duration of time. According to U.S EIA 2016 outlook, the current natural gas consumption is 26.7 quadrillion Btu and is expected to rise to 30.5 quadrillion Btu- an increase of 14%. [1] Consequently, the increase in consumption has lead to development of more natural gas well pads. The fugitive methane emissions for these production facilities present an uncertain future towards natural gas' reputation as a cleaner fossil fuel. Currently, Marcellus shale play accounts for 40% of the total natural gas production making it the largest producer by a factor of 2.6. [2] However, due to the complexities in measurements largely due to the size, topology and other biogenic sources, Marcellus shale has remained relatively untouched for research purposes.

Continuing the efforts from the summer and fall of 2015, Princeton Atmospheric Chemistry Experiment (PACE) was deployed for a two week campaign in northeast Pennsylvania and a one week assignment in southwest Pennsylvania, sampling~500 wells over the course of three weeks. PACE spatially profiled the CH_4, CO_2, C_2H_6 and NH_3 concentrations using LI-7700, LI-7500A, Ethane and Ammonia sensors, respectively. Additionally, a tower setup with LI-7700, LI-7500A, and a sonic anemometer was deployed in combination with PACE to determine the role of atmospheric turbulence on the sampling techniques. The overall goal of this campaign is to provide a robust distribution of emissions in the Marcellus shale with an emphasis on the upper end, known as 'super-emitters' that are responsible for most of the emissions. Previous work has shown that 10% of sites can be responsible for 60% of emissions.[3]

The emissions of methane were calculated for sites using an inverse Gaussian plume (IGM) approach. As part of this analysis, the emissions were examined over various sets of time intervals including hourly, weekly and yearly. This analysis was employed to study the variation



in emission rates of the well pad using the IGM.

Fig(1) LI-7700, LI-7500A, airmar, and ethane on PACE. Fig(2) the tower setup with the sonic anemometer

[1] U.S Energy Administration 2016 Annual Energy Outlook.http://www.eia.gov/forecasts/ieo/pdf/0484(2016).pdf (Accessed July 20,2016).

[2] "Drilling Productivity Report." *U.S. Energy Information Administration (EIA)*. U.S Department of Energy, 18 July 2016. Web. 20 July 2016.

[3] Lane, Haley. *Fugitive Methane Emissions in the Marcellus Shale Region: Characterizing the Natural Gas Emissions Distribution Using a Mobile Measurement Platform.* Senior Thesis. Princeton University. 2016. Web 21 Jul. 2016.