Methane Emissions from Natural Gas Production in Pennsylvania: Aircraft Model Comparison

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Leaks in natural gas infrastructure release methane (CH_4), a potent greenhouse gas, into the atmosphere. The estimated fugitive emission rate associated with the production and transportation of natural gas is uncertain, hindering our understanding of the energy's efficacy as a "bridge fuel". This study presents a new application of inverse methodology for estimating regional emission rates from natural gas production. An inventory of methane emissions was compiled for major sources in Pennsylvania. This inventory was coupled to the Weather Research and Forecasting model with chemistry enabled (WRF-Chem) and atmospheric CH_4 concentration fields at 3km resolution were generated. Projected atmospheric CH_4 enhancements from WRF-Chem were compared to observations obtained from a three-week flight campaign in May 2015, performed by a team from the NOAA Global Monitoring Division and the University of Michigan. Emission rates from unconventional wells and compressor stations were adjusted in the model to minimize errors between aircraft observations and the model-simulated concentrations for each flight, and an optimal emission rate is solved for. Average emission rates for the region are found to be approximately half a percent of unconventional natural gas production during the period. Similar results are obtained through changes in model configurations and optimization methods, and mass balance calculations using aircraft data on days with applicable flight patterns also reach a similar conclusion, providing a sense of robustness to calculated emission rate. Despite confidence in the mean emission rate, large variations are present in emission rates across individual days of the flights in both the model optimization and mass balance results. There is still uncertainty as to whether these daily differences are associated with errors of the day or rather are temporal variability in natural gas emissions, though agreement in the daily trends between the different methodologies may be indicative of the latter.

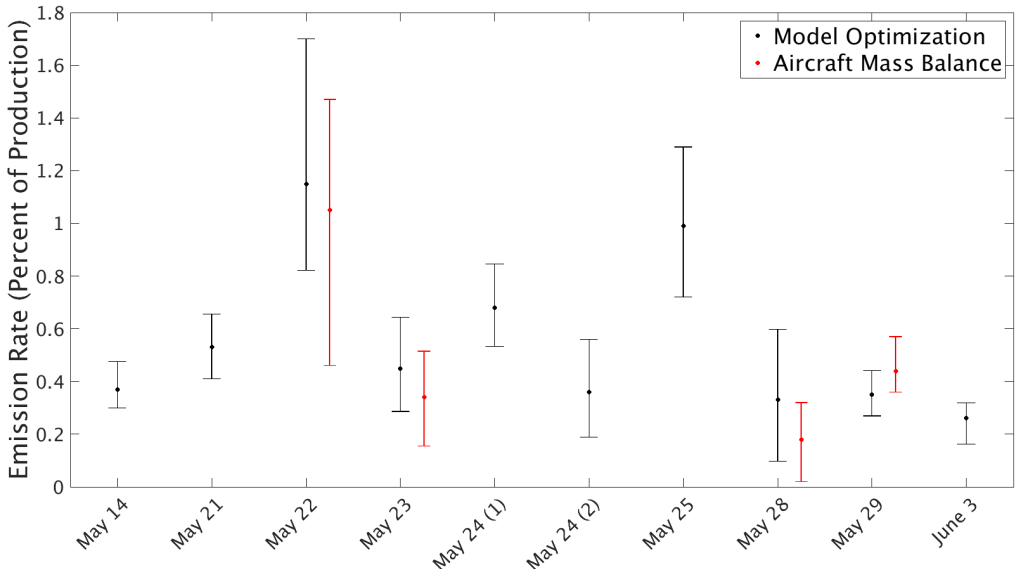

Figure 1. Natural gas emission rates in northeastern Pennsylvania as a function of production, calculated using model optimization technique (black) and mass balance technique (red) when applicable. Error bars represent a potential background value error of ±5ppb.