Comparison of facility-level methane emissions from natural gas production well pads in the Marcellus, Denver-Julesburg, and Uintah Basins—preliminary measurement results

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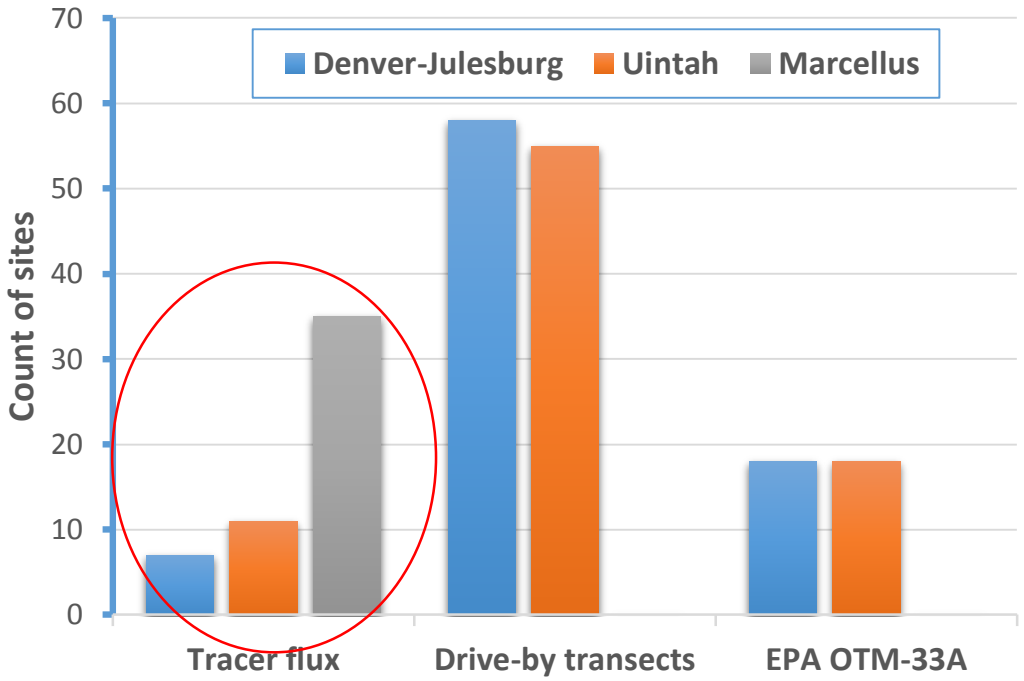
Study overview

- Facility-level methane emission rates were evaluated for natural gas (NG) production well pads in the Marcellus region, project funded by the DOE-NETL. Ground-based downwind tracer flux measurements were performed between June 2014 and February 2015.

- Measurements of facility-level CH_4 emission rates for routinely producing NG well pads were performed in Denver-Julesburg (March—April, 2015) and Uintah (April—May, 2015). This project is funded by NOAA.

Study overview

- For the D-J and Uintah measurements, a mix of tracer flux, EPA OTM 33A, and drive-by transects utilizing Gaussian plume inverse modeling were performed. Only tracer flux measurement results are presented here.



Overarching study goals and research questions

- Assess facility-level methane emission rates from actively producing NG well pads. How do site-specific CH_4 emission rates vary within and among shale Basins?

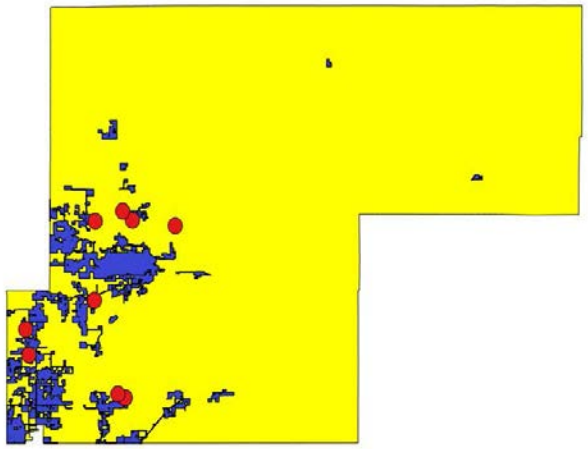
- What factors influence variabilities in site-specific CH_4 emission rates?

- How do ground-based facility-level CH_4 emissions measurements compare with top-down airborne measurements?

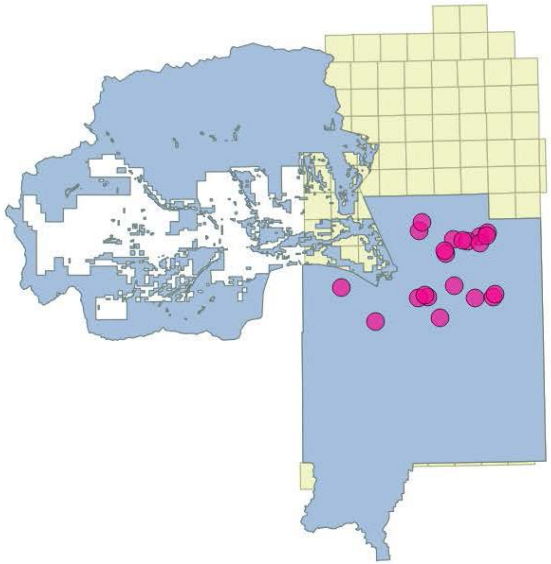
- How comparable are measured CH_4 emissions with inventory CH_4 emissions? What factors might account for discrepancies?

Tracer flux sites

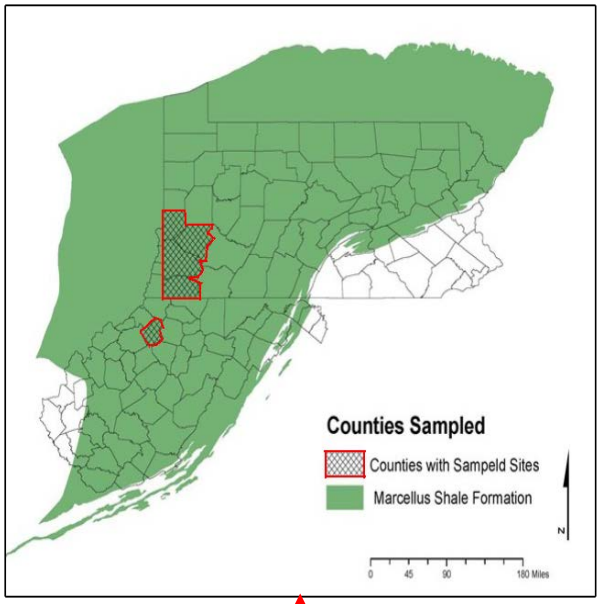
- Sites were selected based on road access, proximity of potentially interfering methane sources, local terrain, and meteorological conditions on the day of sampling.



Weld County, CO
(7 sites)

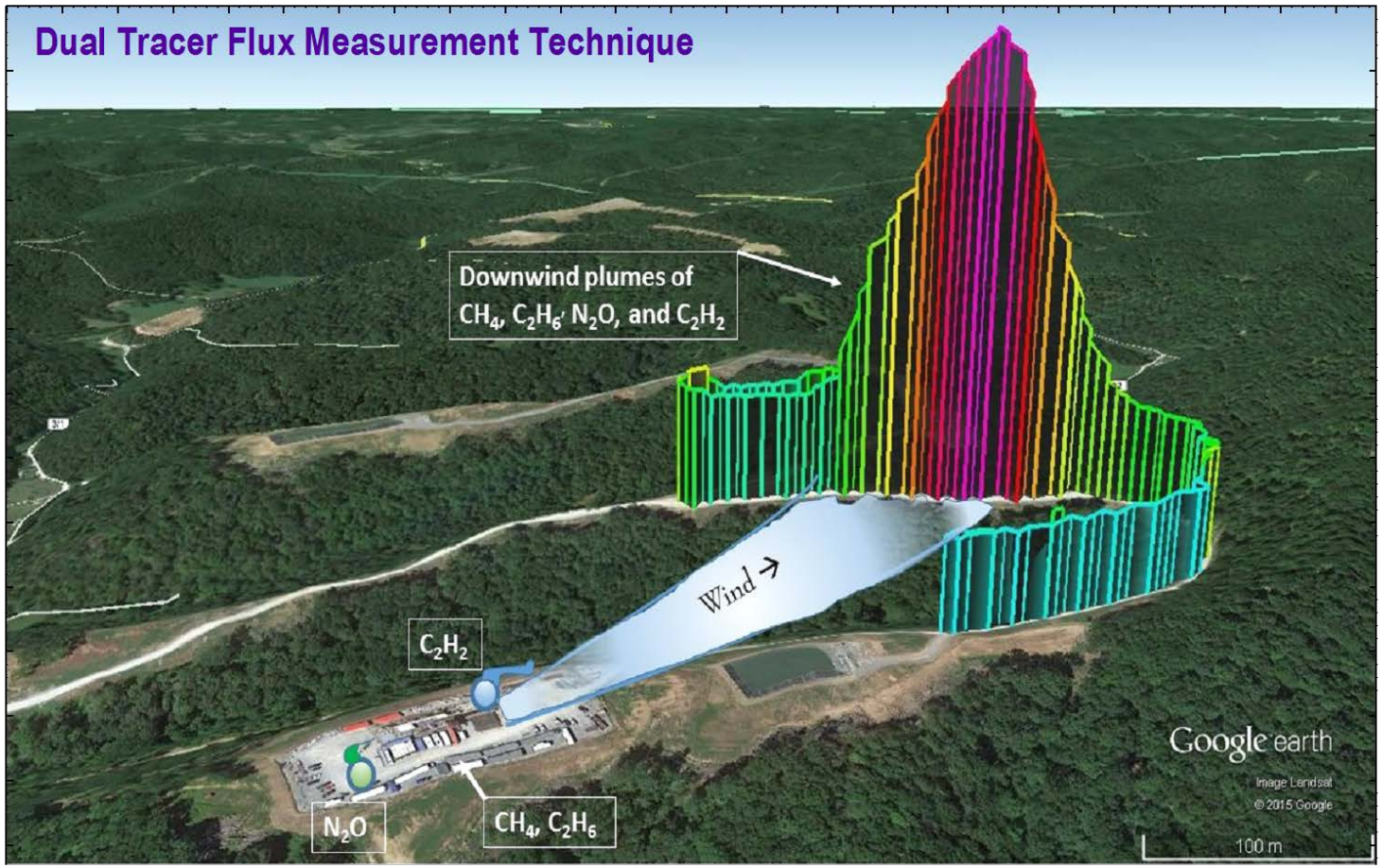


Uintah County, UT
(11 sites)



Pennsylvania and WV sites
(35 sites), includes 18
conventional well pads

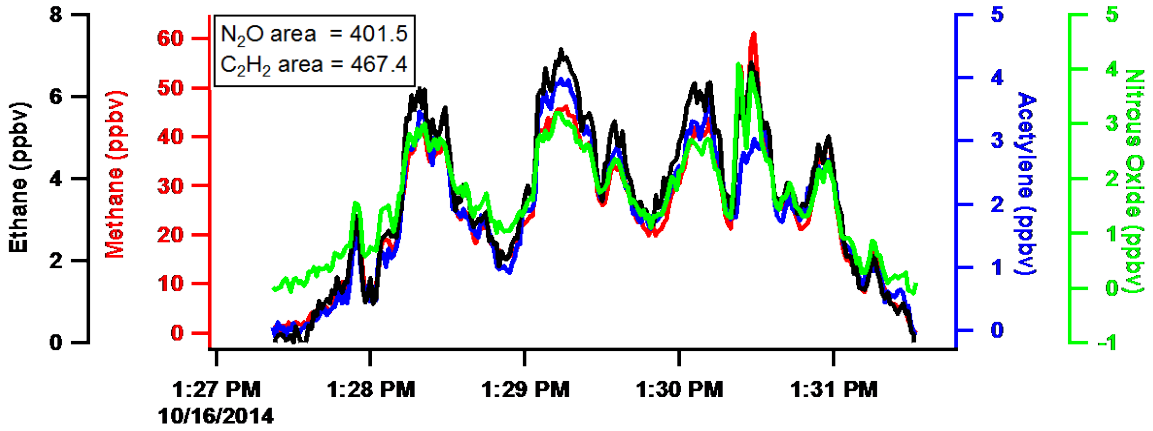
A brief description of the dual tracer flux measurement approach

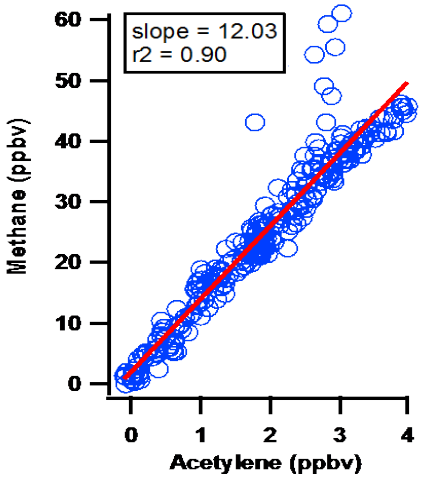


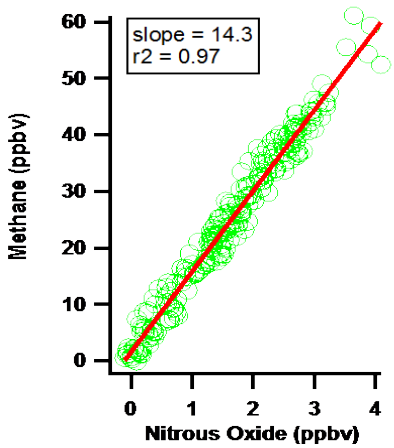
Two tracers, acetylene (C_2H_2) and nitrous oxide (N_2O) are released at known flow rates within close proximity to the potential CH_4 emission source. A mobile laboratory is used to intercept dispersed plumes (CH_4, C_2H_6, N_2O, C_2H_2) 100 m to 1.2 km downwind.

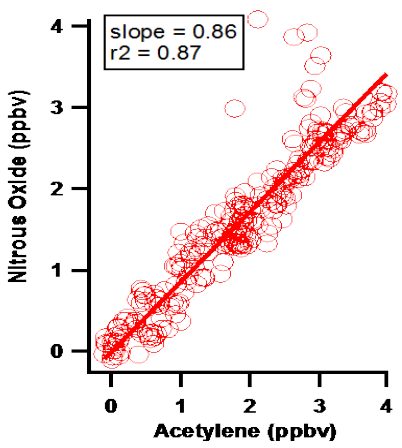
A brief description of the dual tracer flux measurement approach

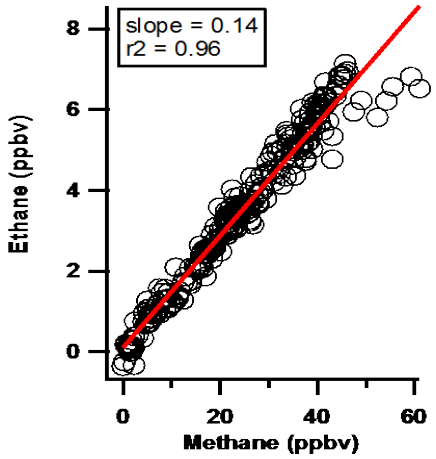
$$CH_4\ emission\ rate = Tracer\ emission\ rate \times \frac{\Delta[CH_4]}{\Delta[Tracer]}$$



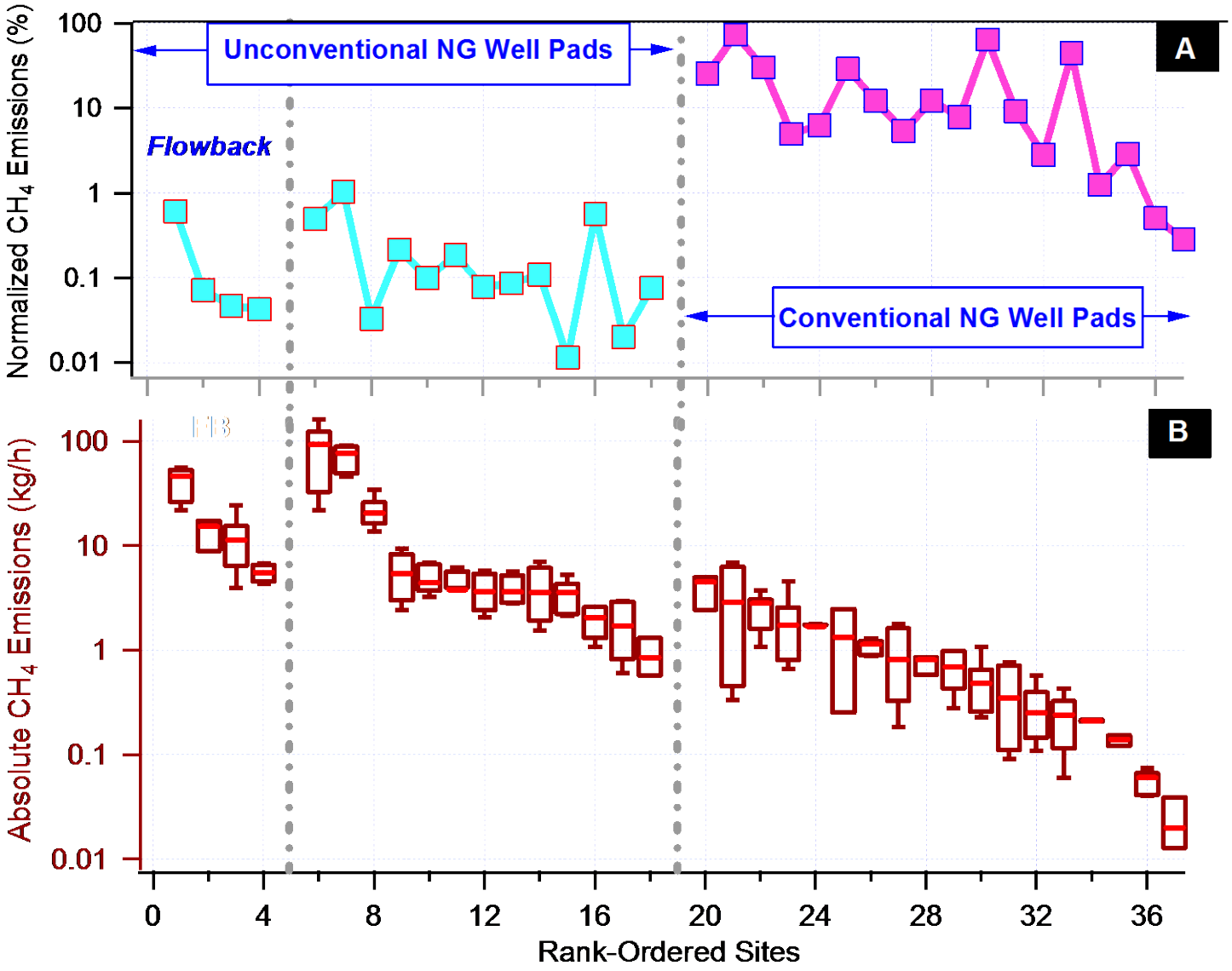




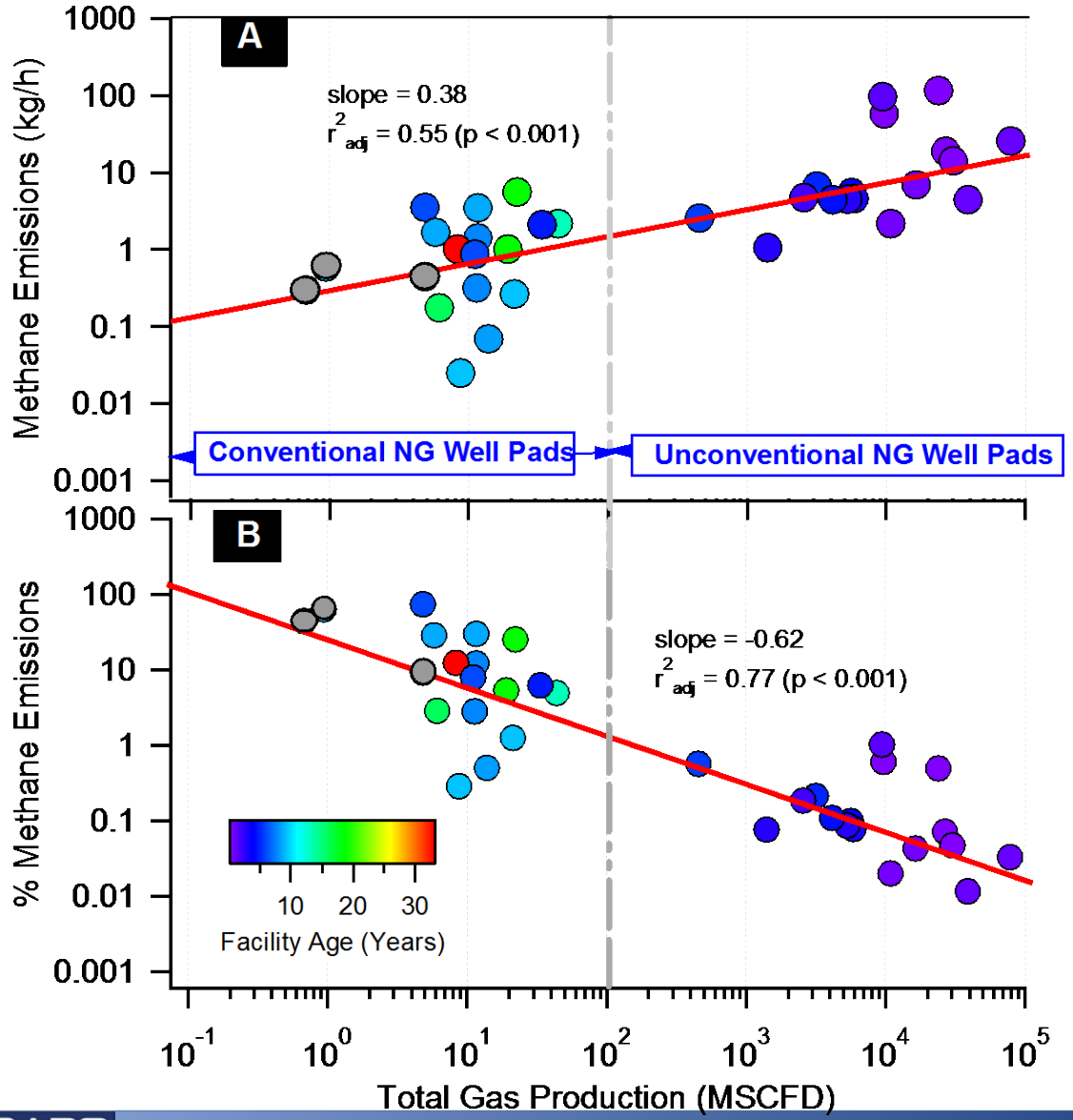




Measurement results—Marcellus Shale region (PA and WV)

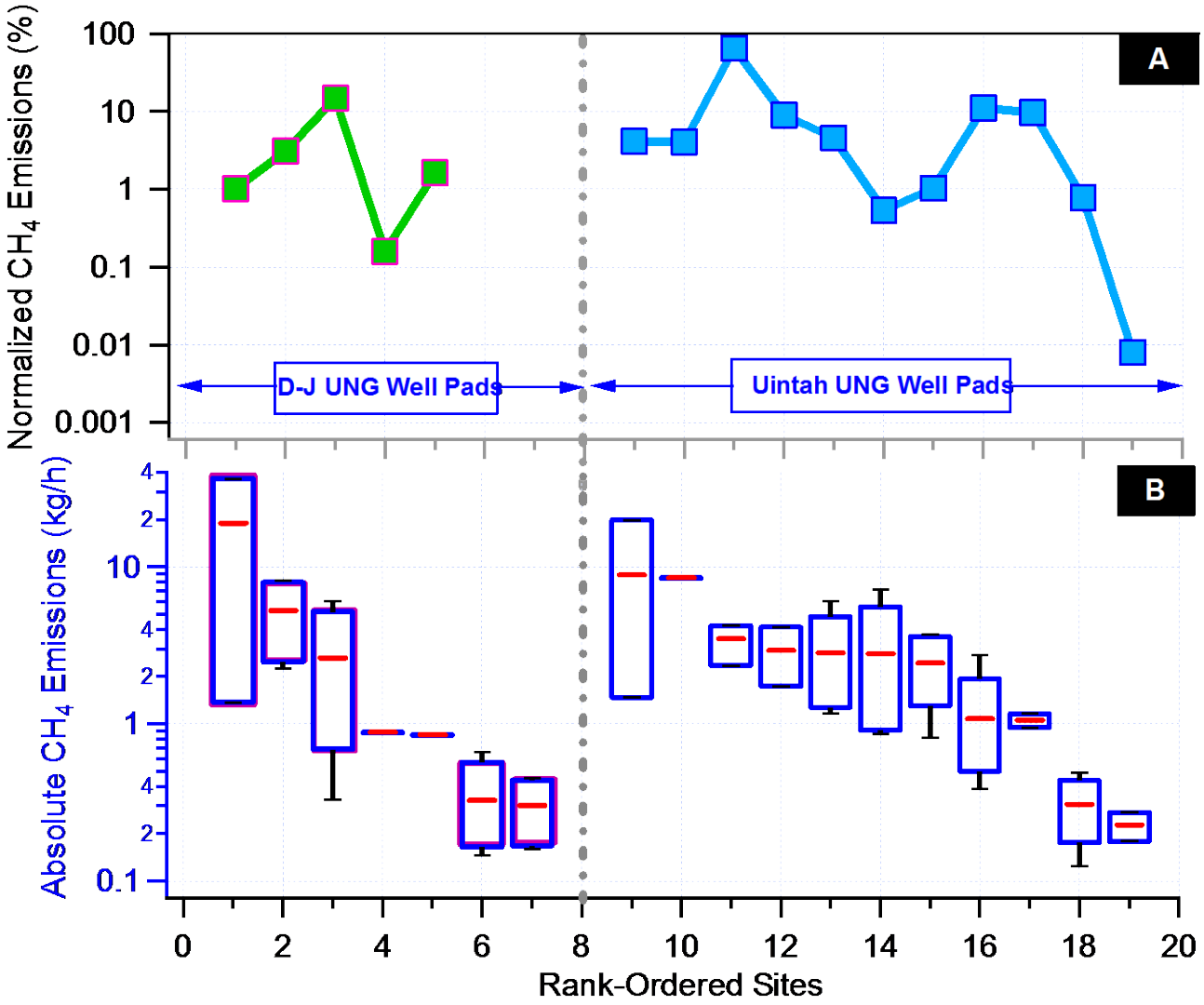


CH_4 emission rates show variability with facility-specific rate of NG production and facility age.



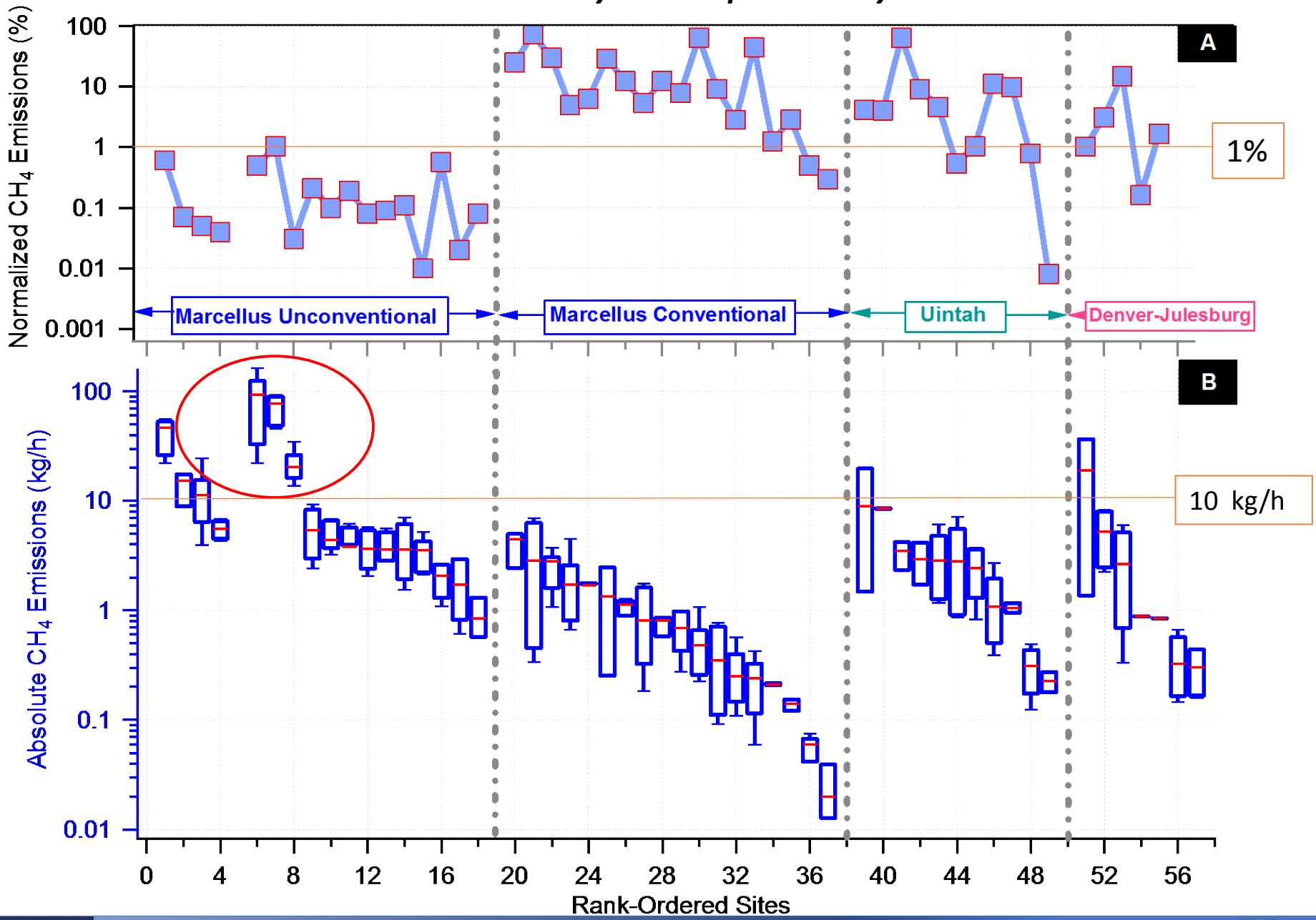
- The newer well pads produce significantly more NG than older well pads, and emit substantially higher CH_4.
- However, the newer UNG well pads emit <1% of total gas production compared to an average of 18% for the generally older C_vNG well pads
- Note the large scatter within each production category

Denver-Julesburg (Weld Cty, CO) and Uintah—preliminary results

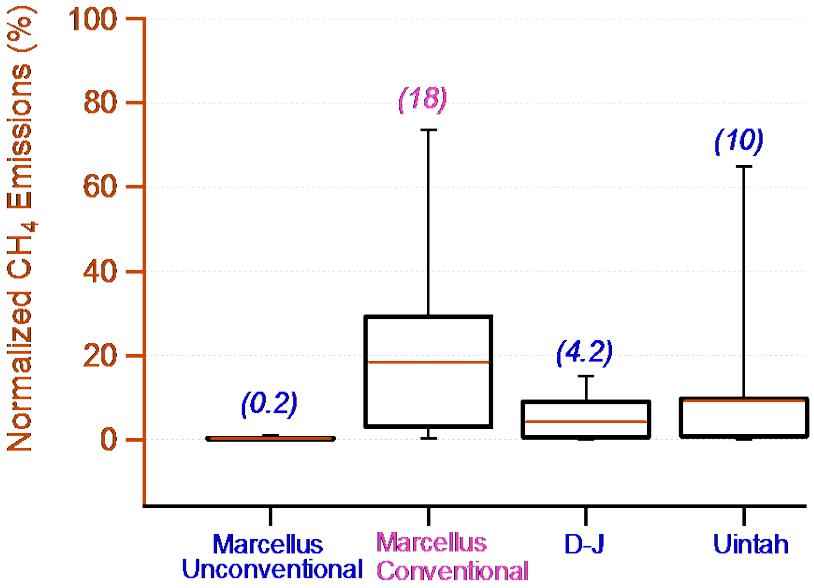


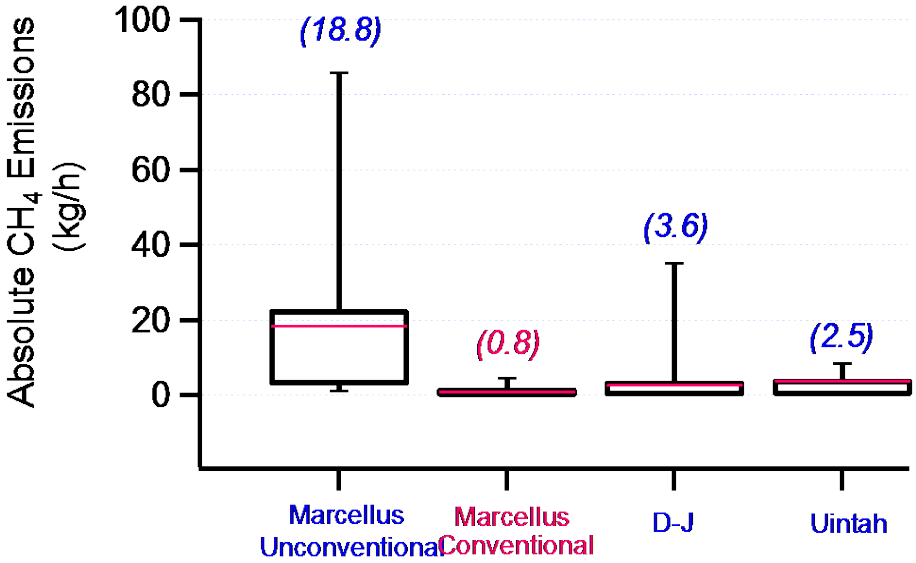
- Absolute facility-level CH_4 emission rates were generally < 10 kg/h and appear to be of similar to Marcellus UNG emissions
- Precise comparisons limited by small sample size

Methane Emissions by Basin—preliminary results

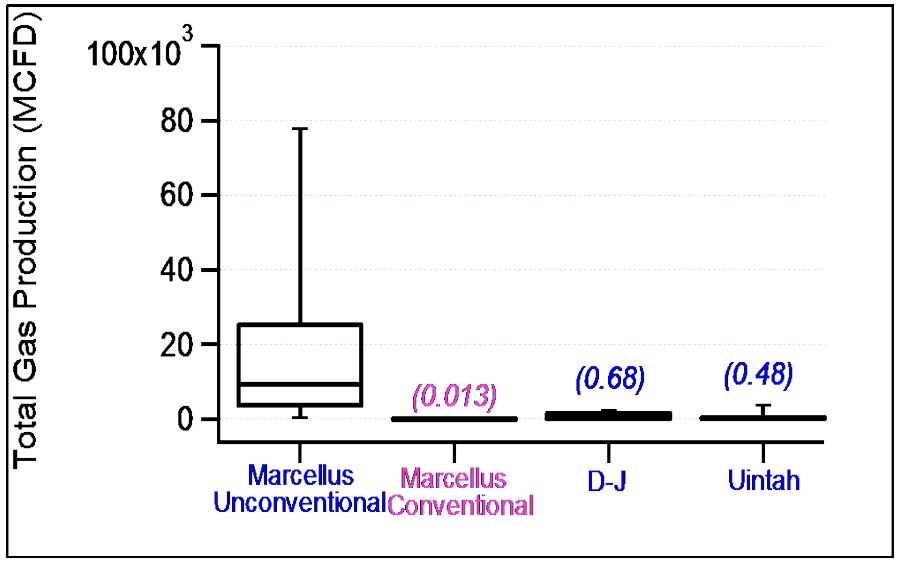


Methane Emissions by Basin—preliminary results



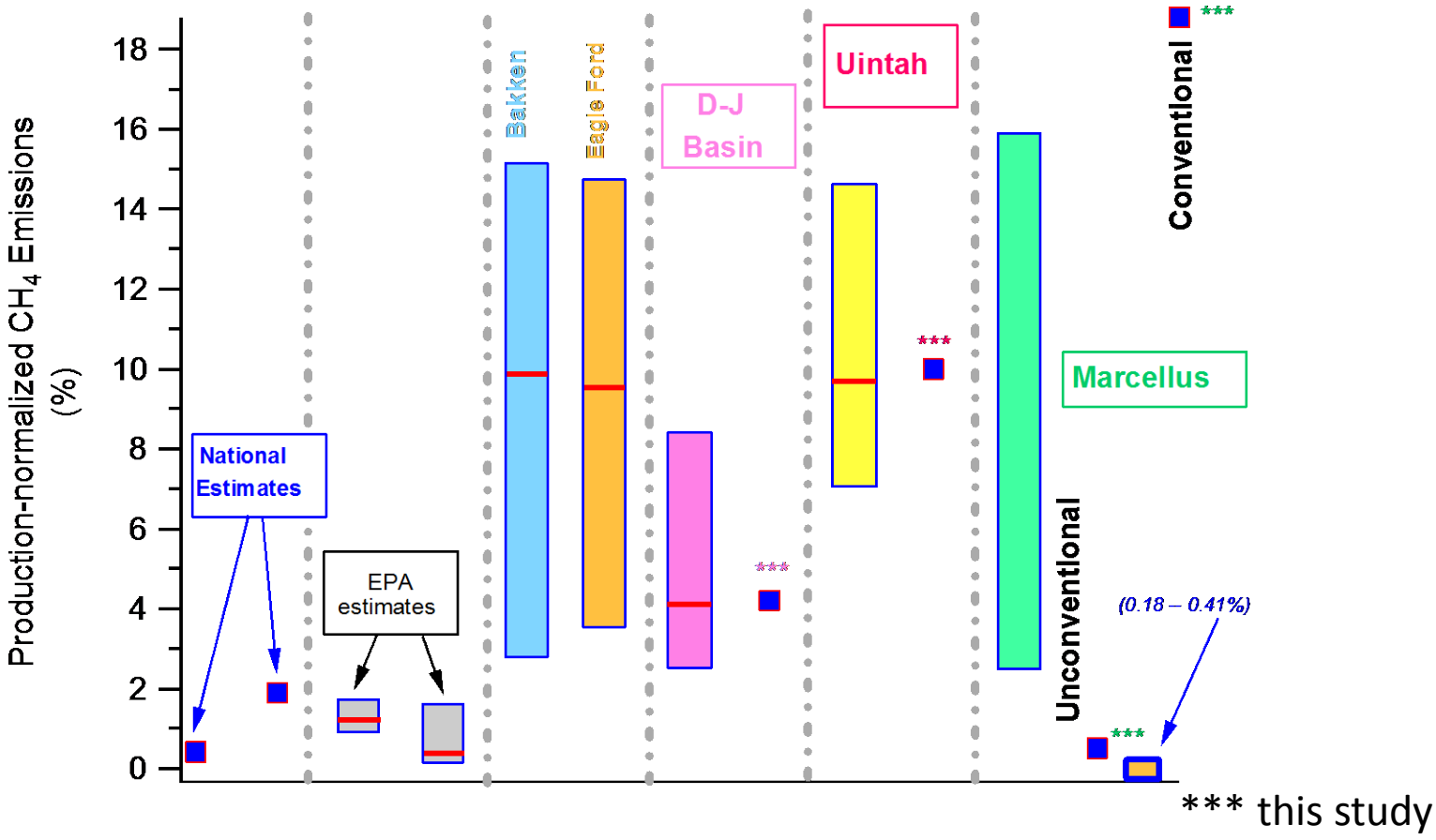


- Facility-specific mean methane emissions (kg/h) are higher for the Marcellus sites



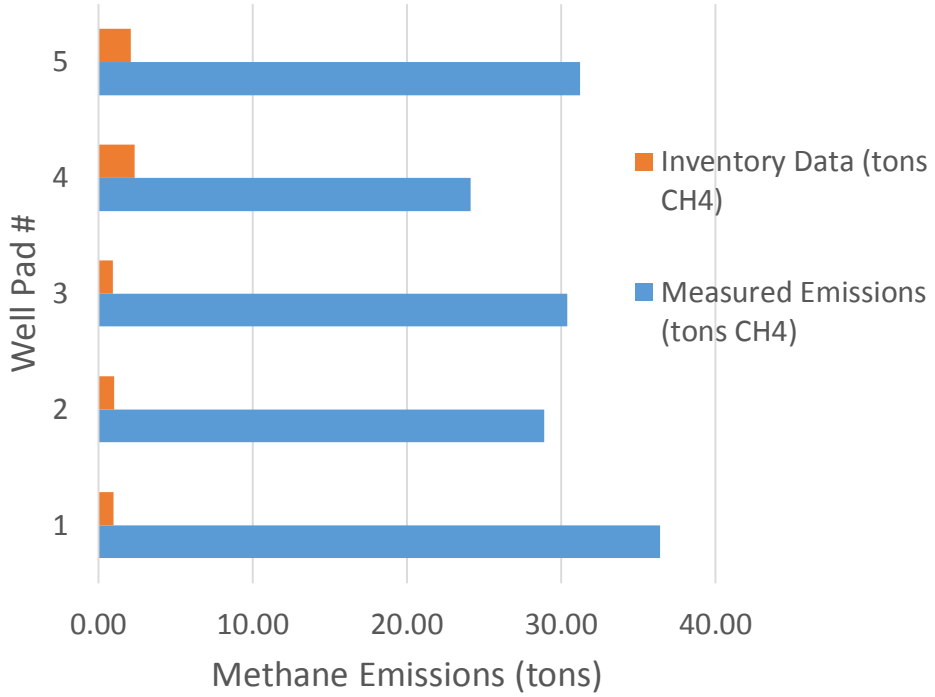
- Marcellus unconventional well pad sites produce up to five orders of magnitude more NG than sites from the D-J and Uintah herein

Variability in production-normalized CH_4 emissions by shale basin



Allen et al. (2013), Alvarez et al. (2012), Schneising et al. (2014), Caulton et al. (2014), Karion et al. (2013), Petron et al. (2014), and Peischl et al (2015)

Comparison of measured CH_4 emissions with inventory data (example for five well pads in Pennsylvania)



- Operator-reported inventory CH_4 emissions data for the five well pads were ~10 times to 37 times less than measured CH_4 emissions.
- In 2013, total CH_4 emissions from *all* CH_4 sources in Pennsylvania were reported to be 108 Gg in the PA inventory. Our results suggest that CH_4 emissions from unconventional NG well pads were ~ 4x the (total) inventory emissions.

Summary and future work

- Preliminary results show that most well pad sites in the Marcellus, D-J, and Uintah emit <10 kg/h methane, with a few high emitting sites skewing mean facility-level methane emissions in the Marcellus (18 kg/h), compared to a mean of 3.6 kg/h and 2.5 kg/h for the D-J and Uintah, respectively.

- The Marcellus appear to have the lowest fraction of total gas produced lost to emissions (<0.5%).

- Additional measurements of facility-level methane emission rates will be conducted in Denver-Julesburg and the Appalachia regions

- Inter-comparison of measurement approaches

Thank you