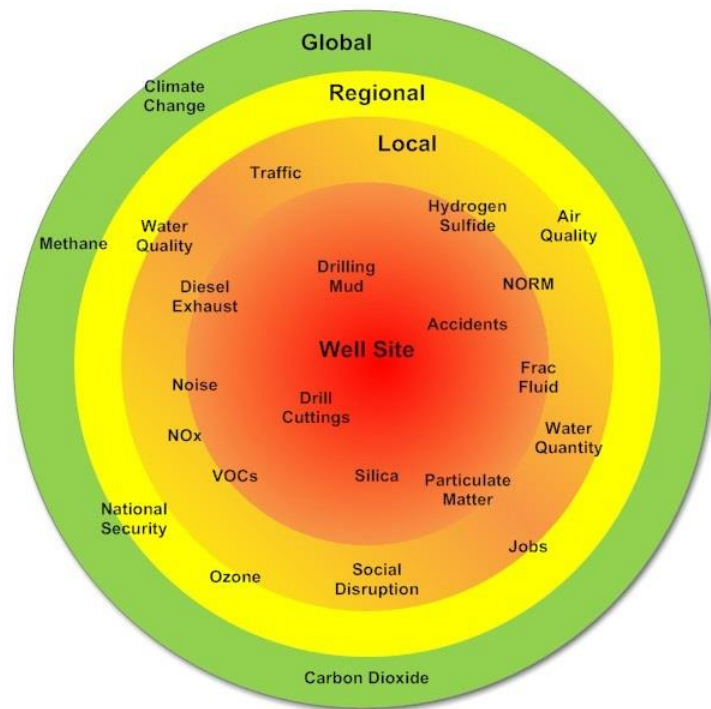


How can we use sensors to learn about air quality near energy/transportation infrastructure?

Mike Hannigan with lots of help from Ashley Collier-Oxandale, Jake Thorson, Joanna Casey, Jill Johnston, Nicole Wong, Hannah Halliday, SCAQMD

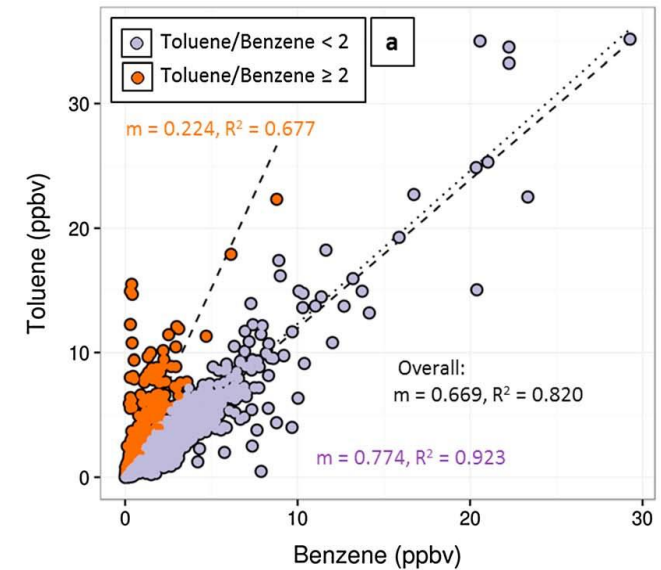
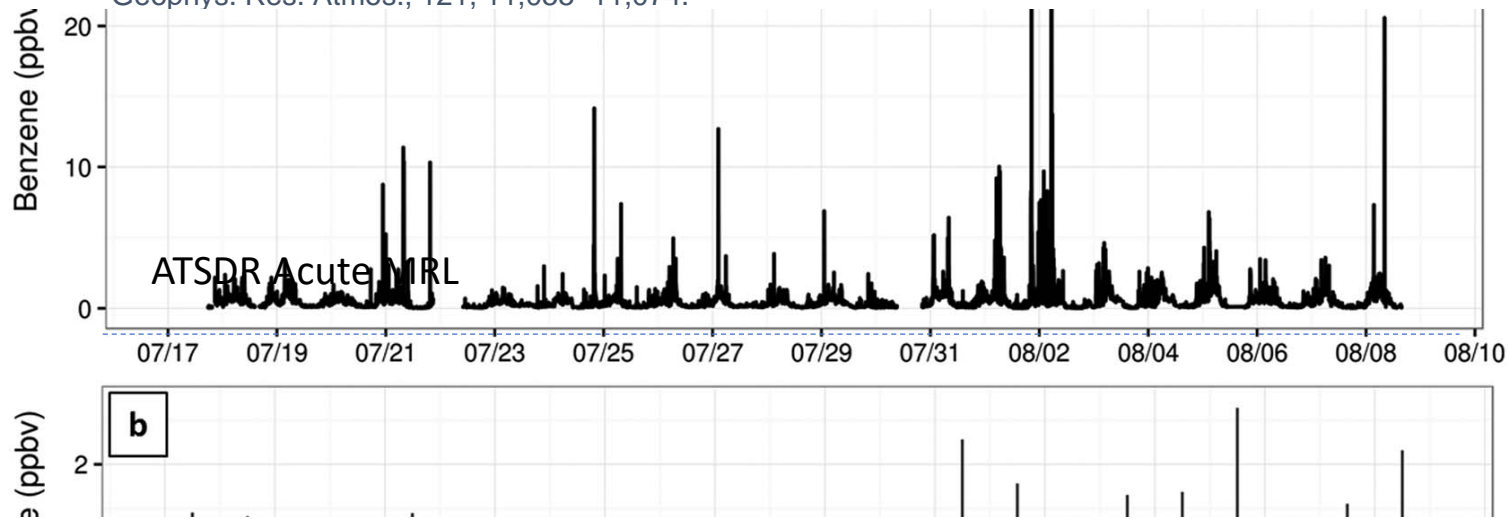


Adgate, J., et al. (2014), Critical Review: Potential public health hazards, exposures and health effects from unconventional natural gas development. Environ Sci Tech, 8307–8320.

Framing the problem

- More air toxics in DJ Basin than estimated from emissions inventory

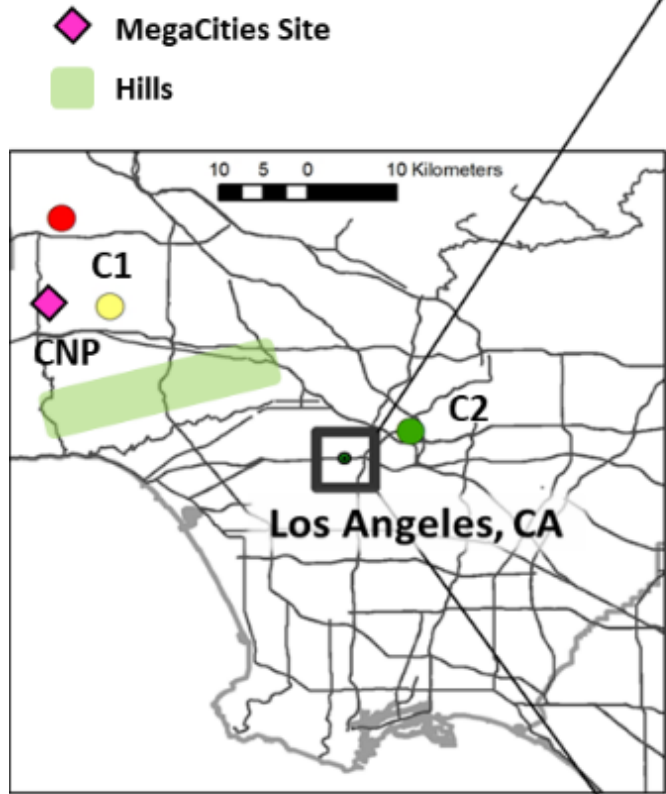
Halliday, H. S., et al., (2016), Atmospheric benzene observations from oil and gas production in the Denver-Julesburg Basin in July and August 2014, *J. Geophys. Res. Atmos.*, 121, 11,055–11,074.



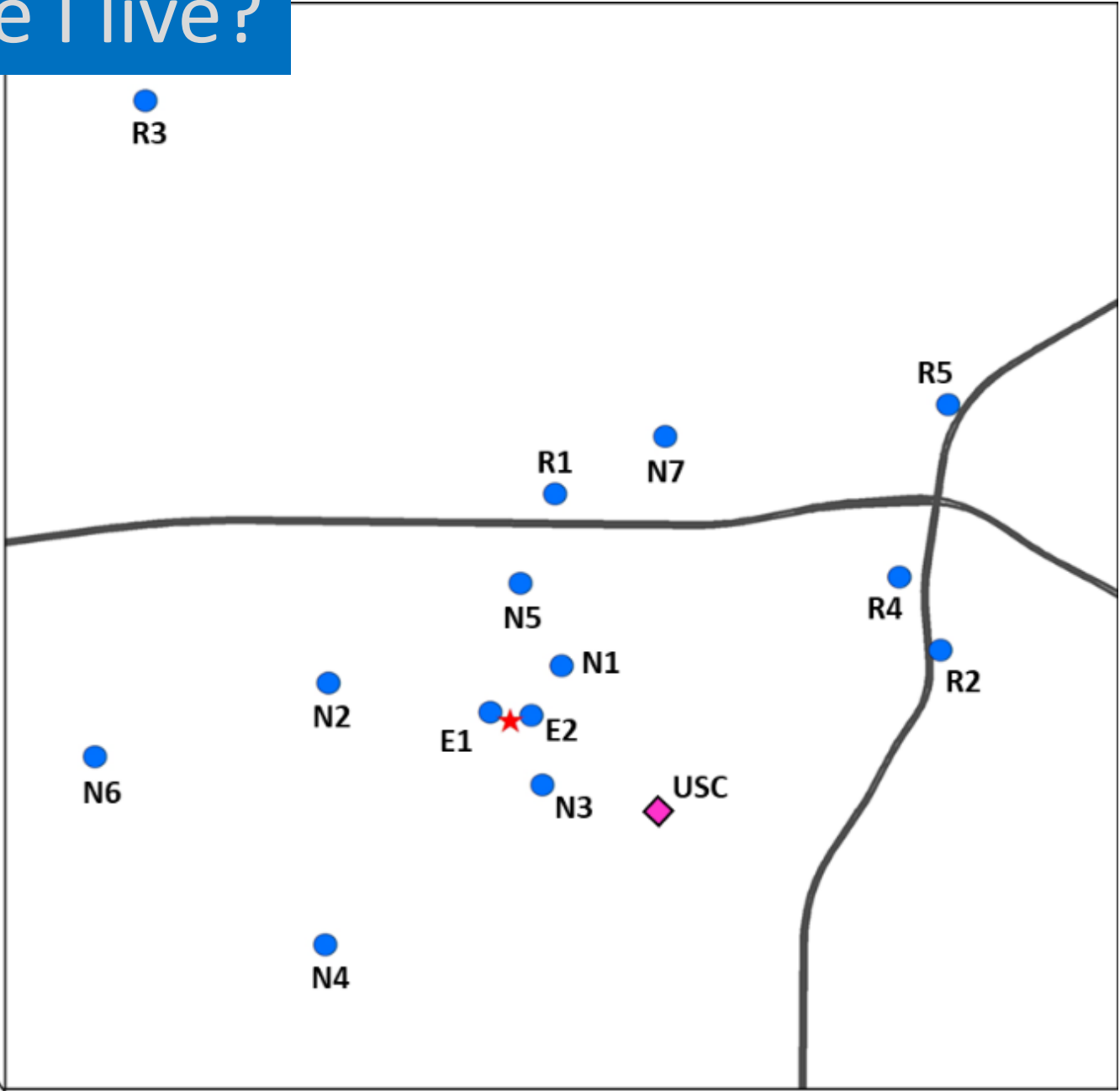
- Benzene from O &G activities similar to cars, likely condensate tanks and fugitive emissions in DJ Basin

Pétron, G., et al. (2014), A new look at methane and nonmethane hydrocarbon emissions from oil and natural gas operations in the Colorado Denver- Julesburg Basin, *J. Geophys. Res. Atmos.*, 119, 6836–6852.

But what about where I live?

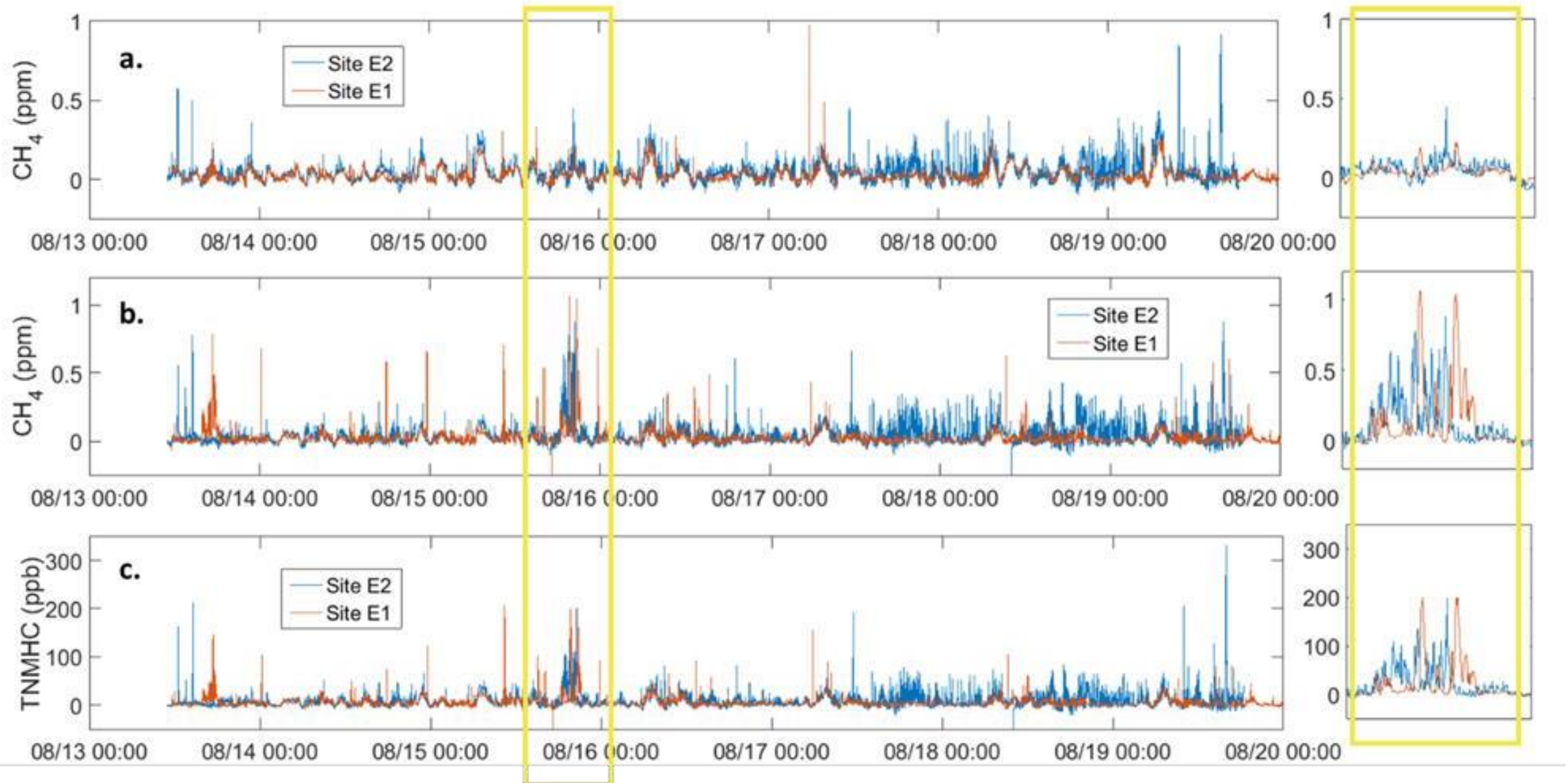


- Reference Site 1
- Reference Site 2
- Additional Co-location Site
- Monitor Location
- ★ Drill Site of Interest

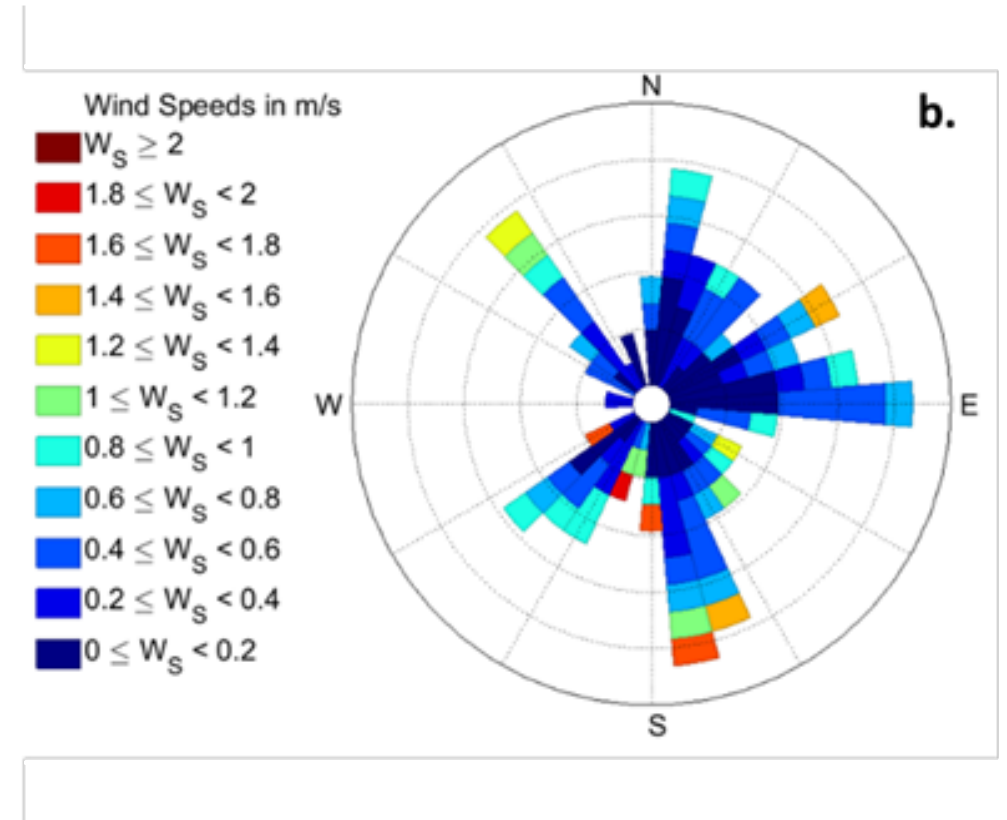
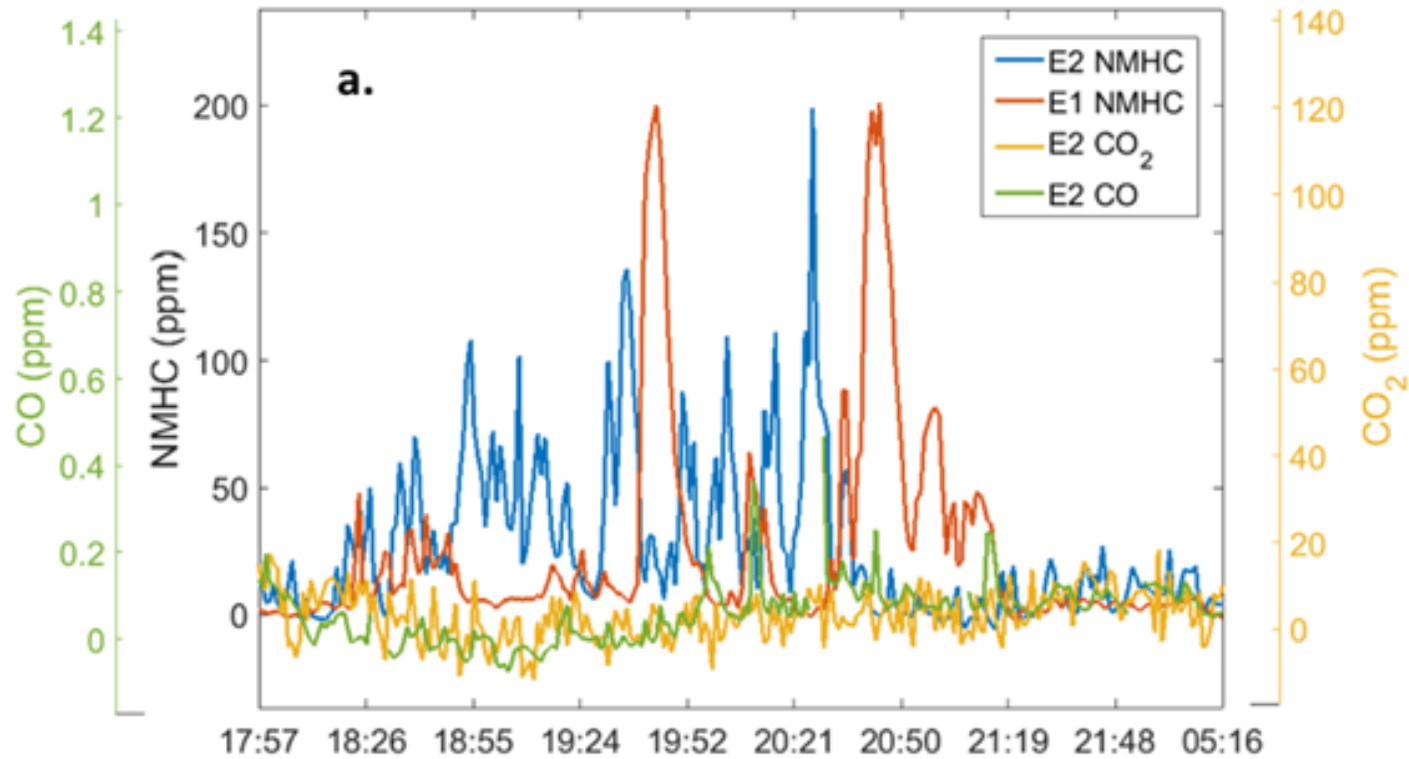


1 0.5 0 1 Kilometers

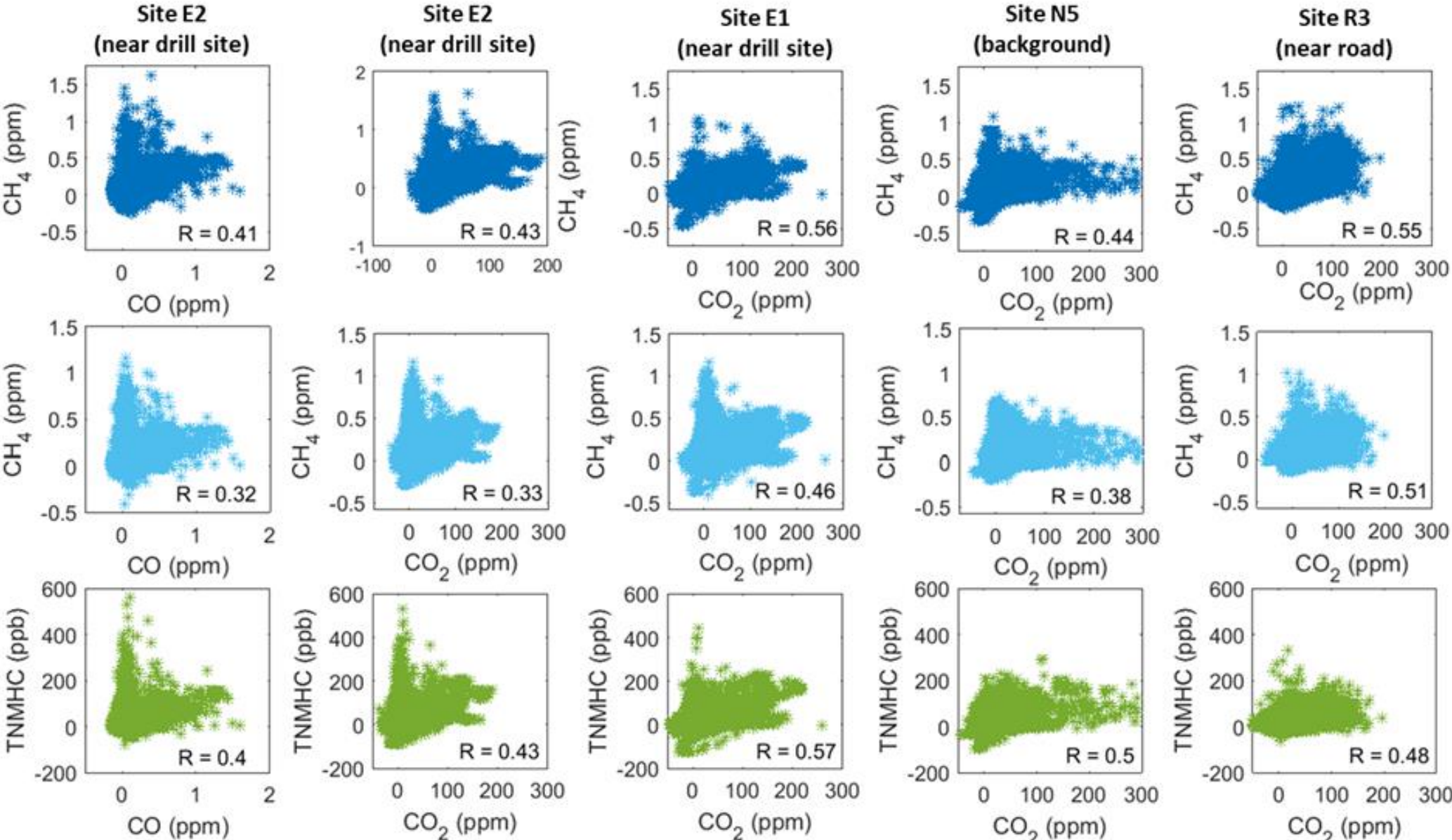
Concentrations* on two sides of the drill site



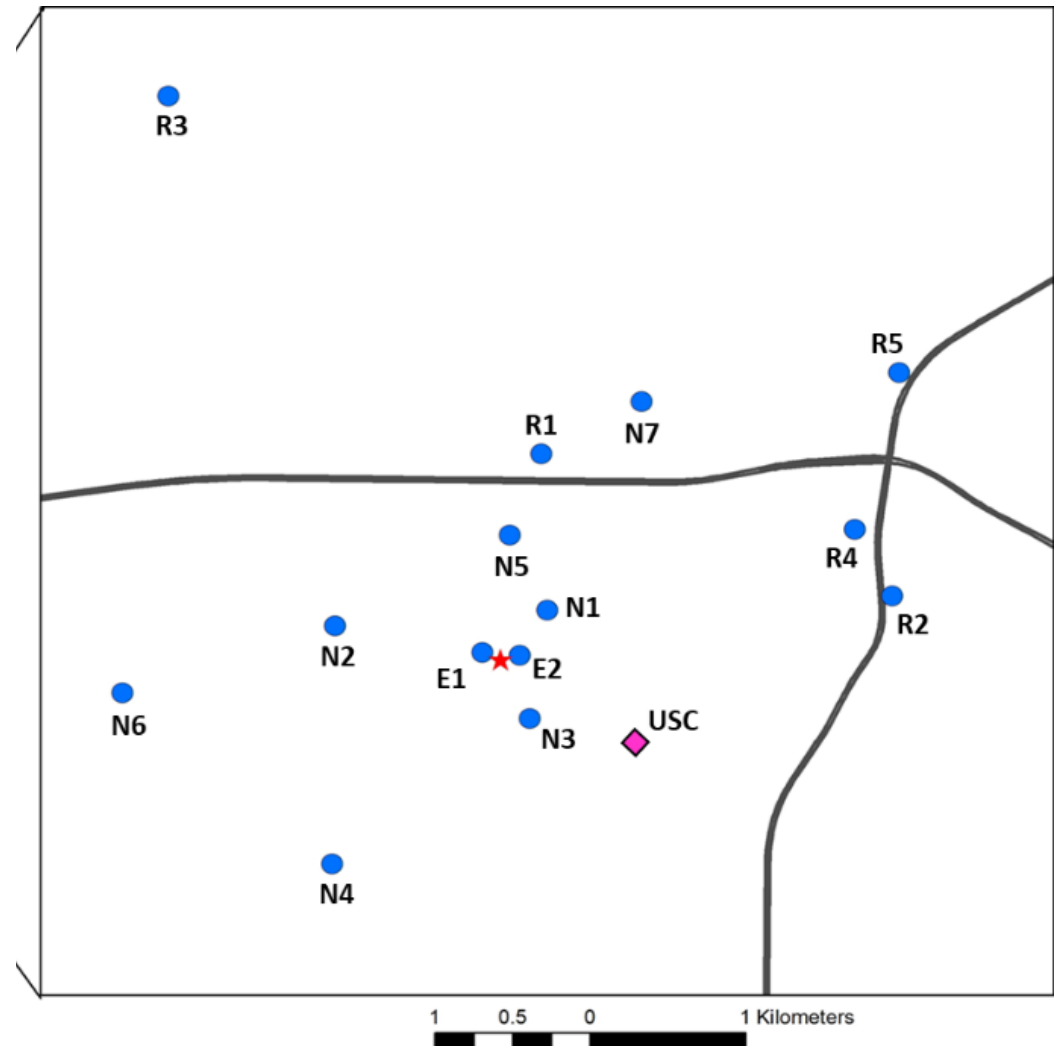
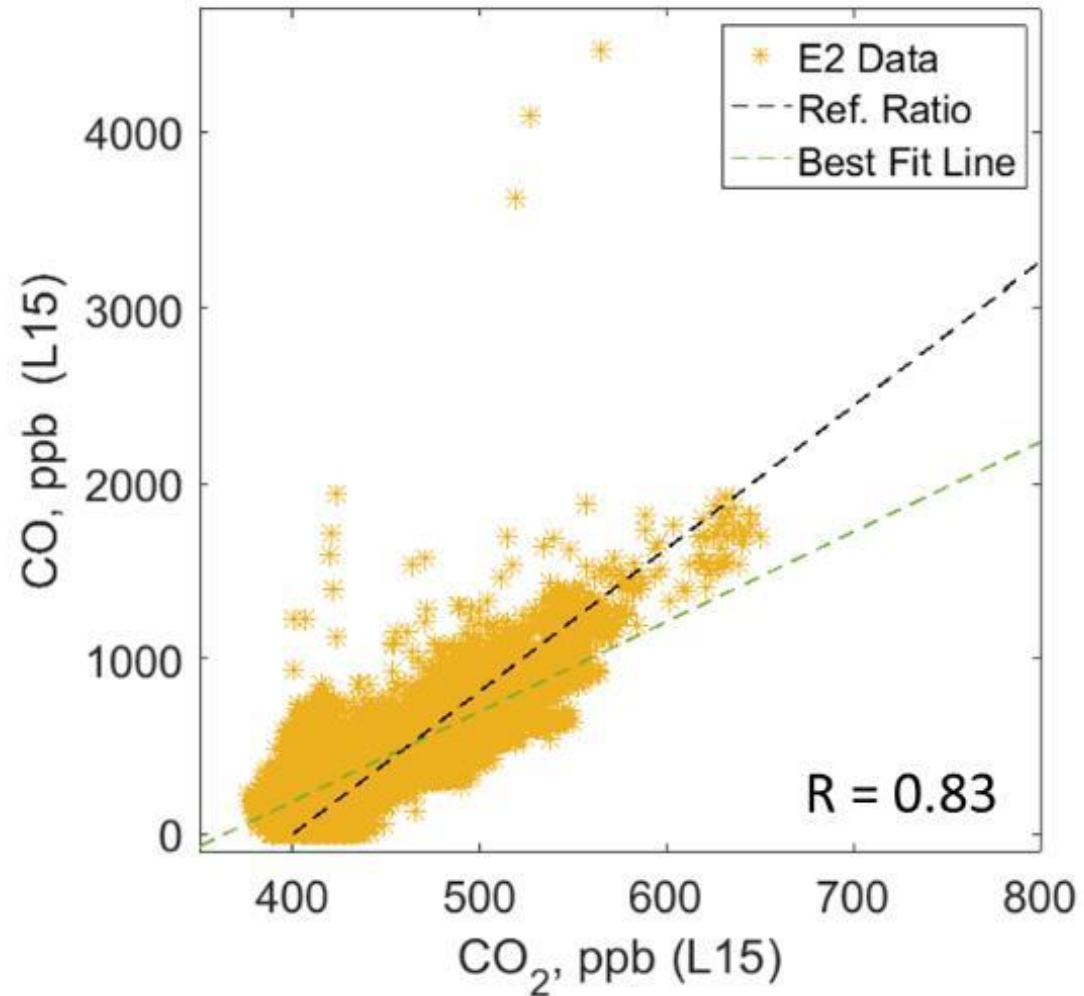
Multiple components help understand origin



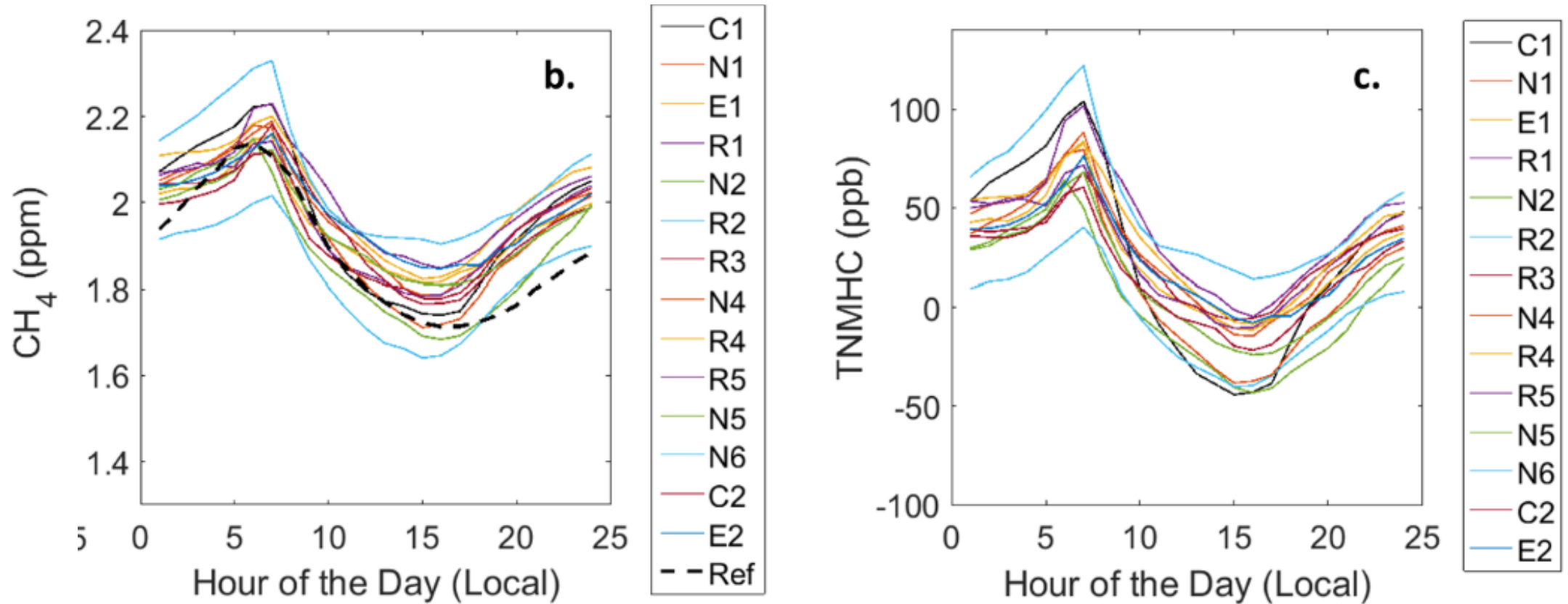
Is there more evidence of non-combustion HC emissions?



What about CO, where is it coming from?

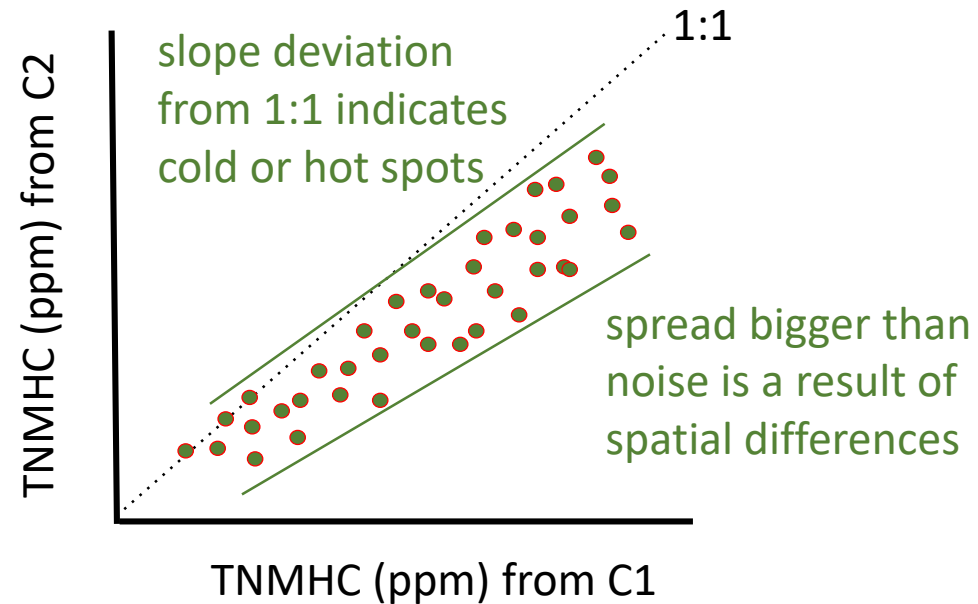
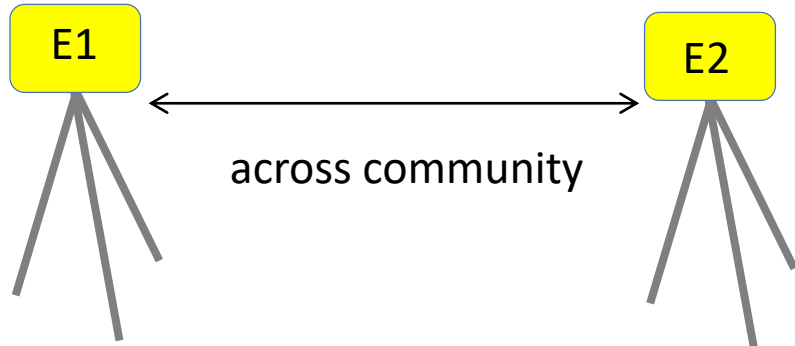
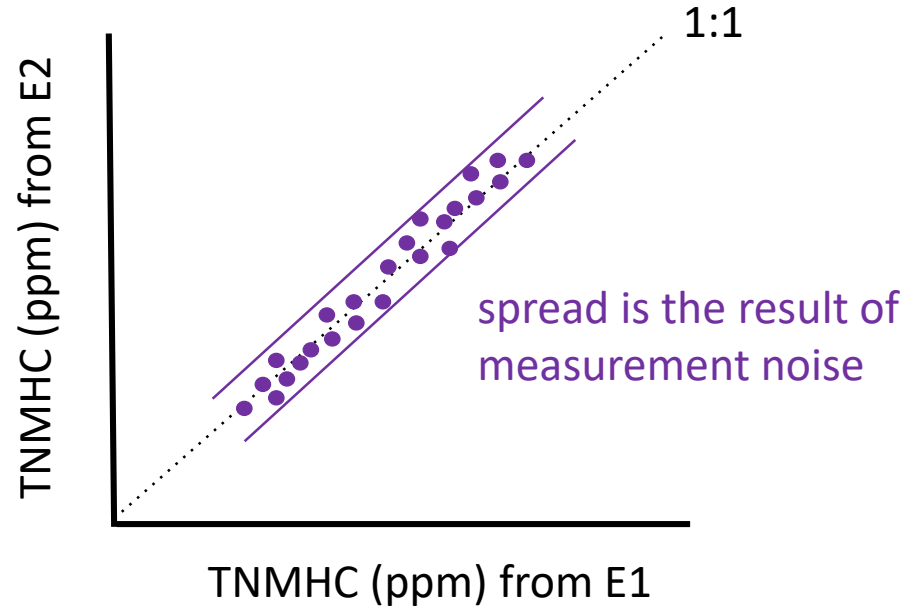
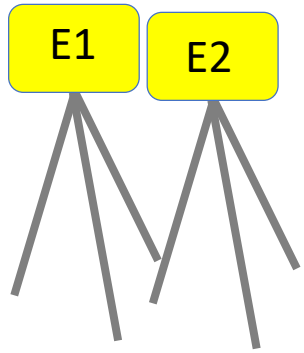


What about the other sites?

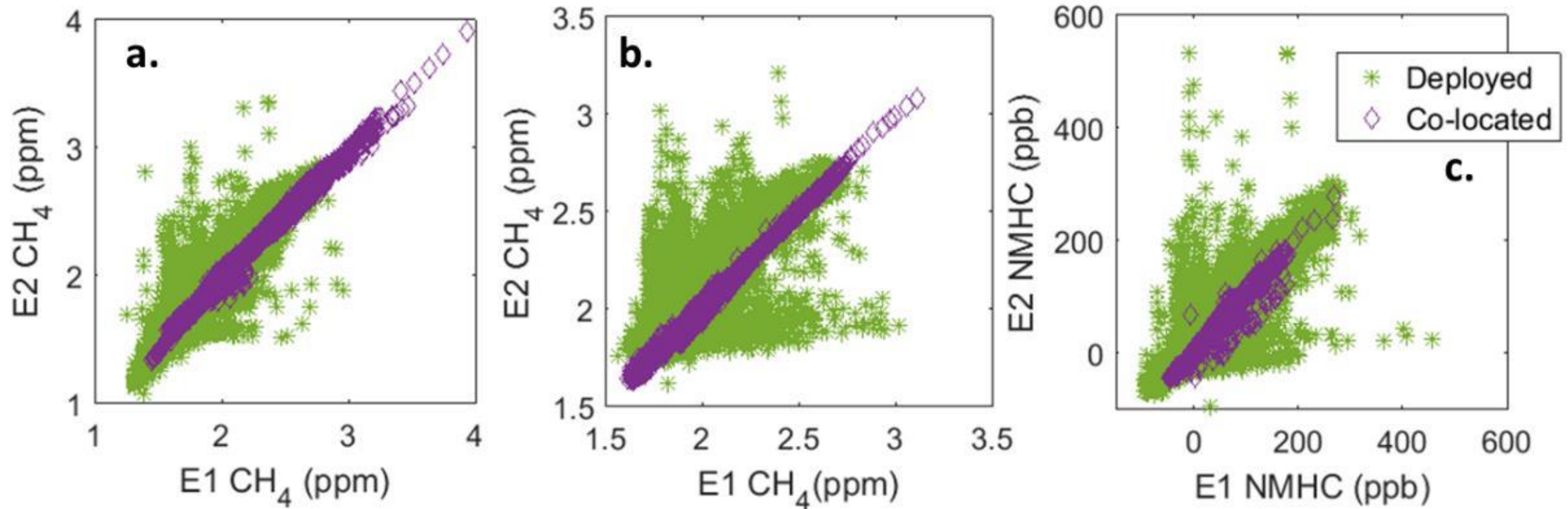


Average concentration by time of day at each site

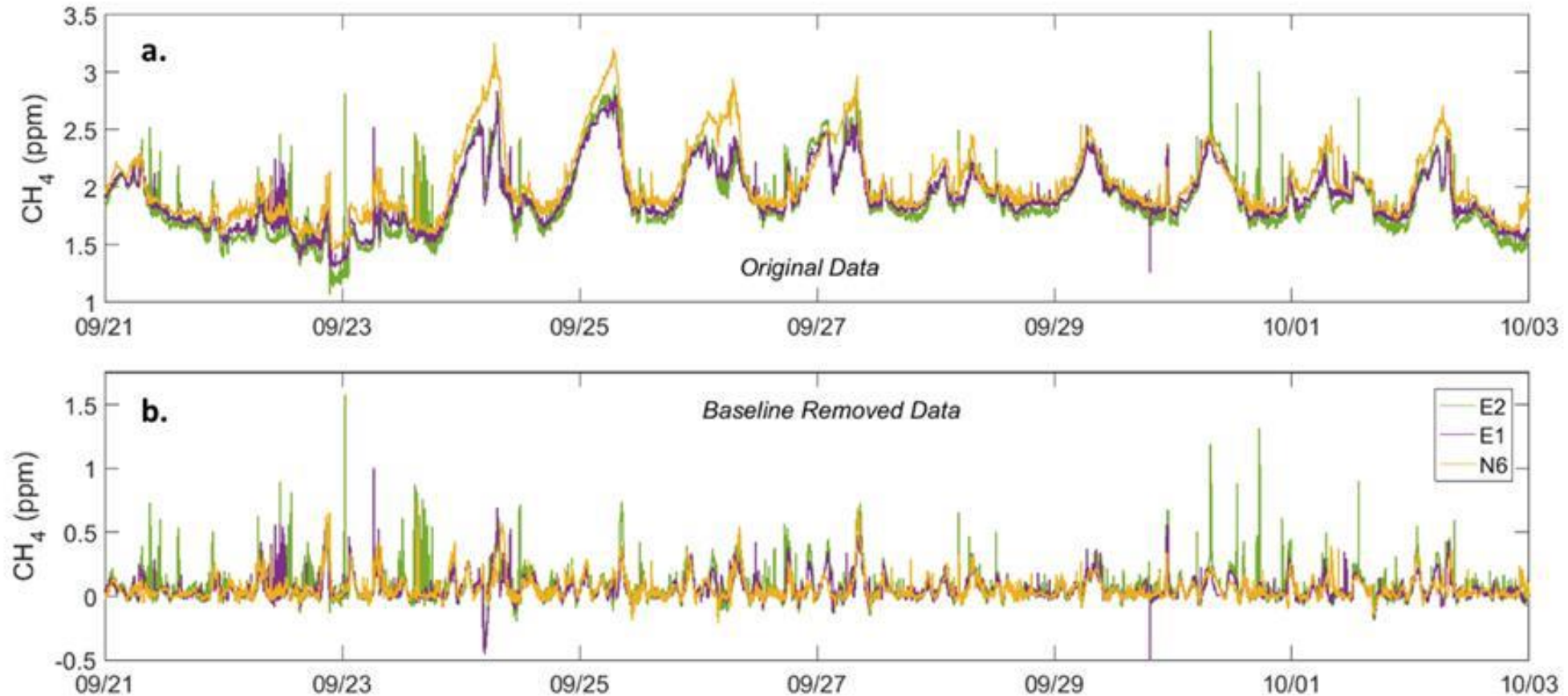
How do we design an experiment?



Comparison to co-location



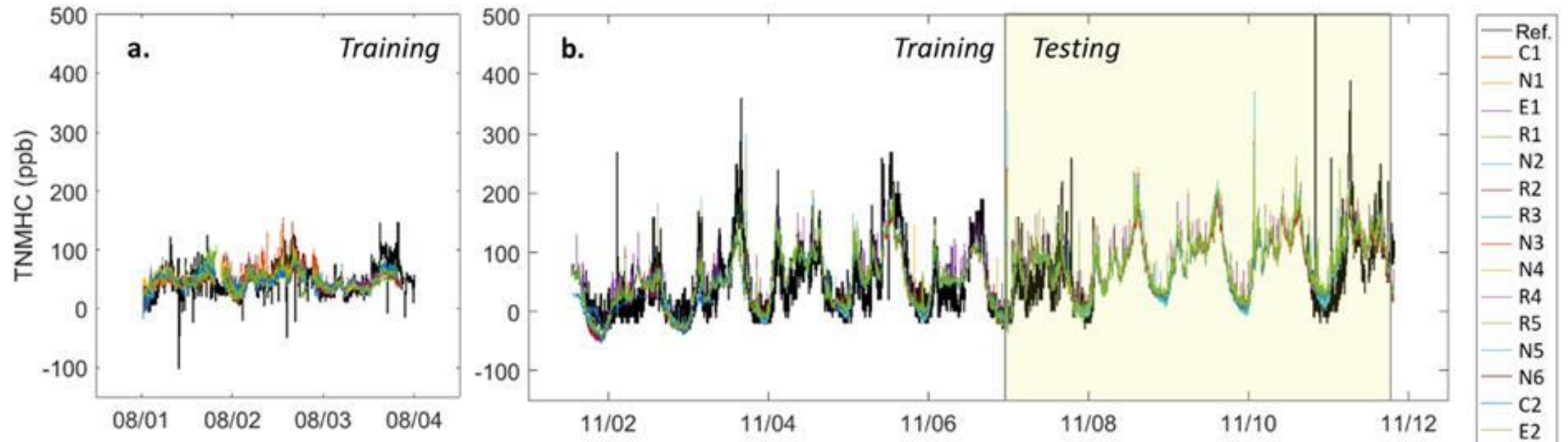
Baseline removal



We used approach from ...

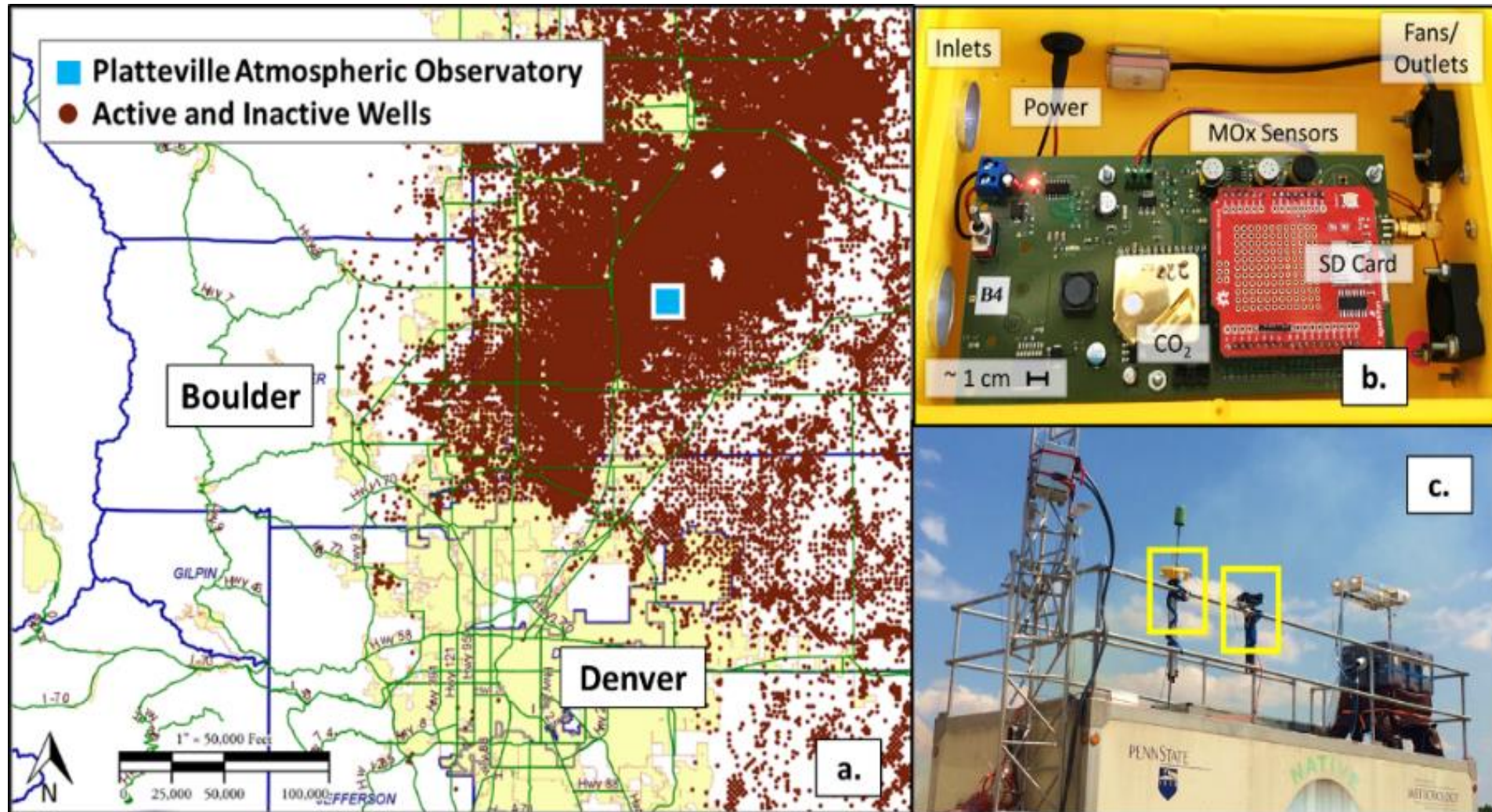
Ruckstuhl, A. F., Henne, S., Reimann, S., Steinbacher, M., Vollmer, M. K., Doherty, S. O., & Buchmann, B. (2012). Robust extraction of baseline signal of atmospheric trace species using local regression, 2613–2624. <http://doi.org/10.5194/amt-5-2613-2012>

Quantification model performance



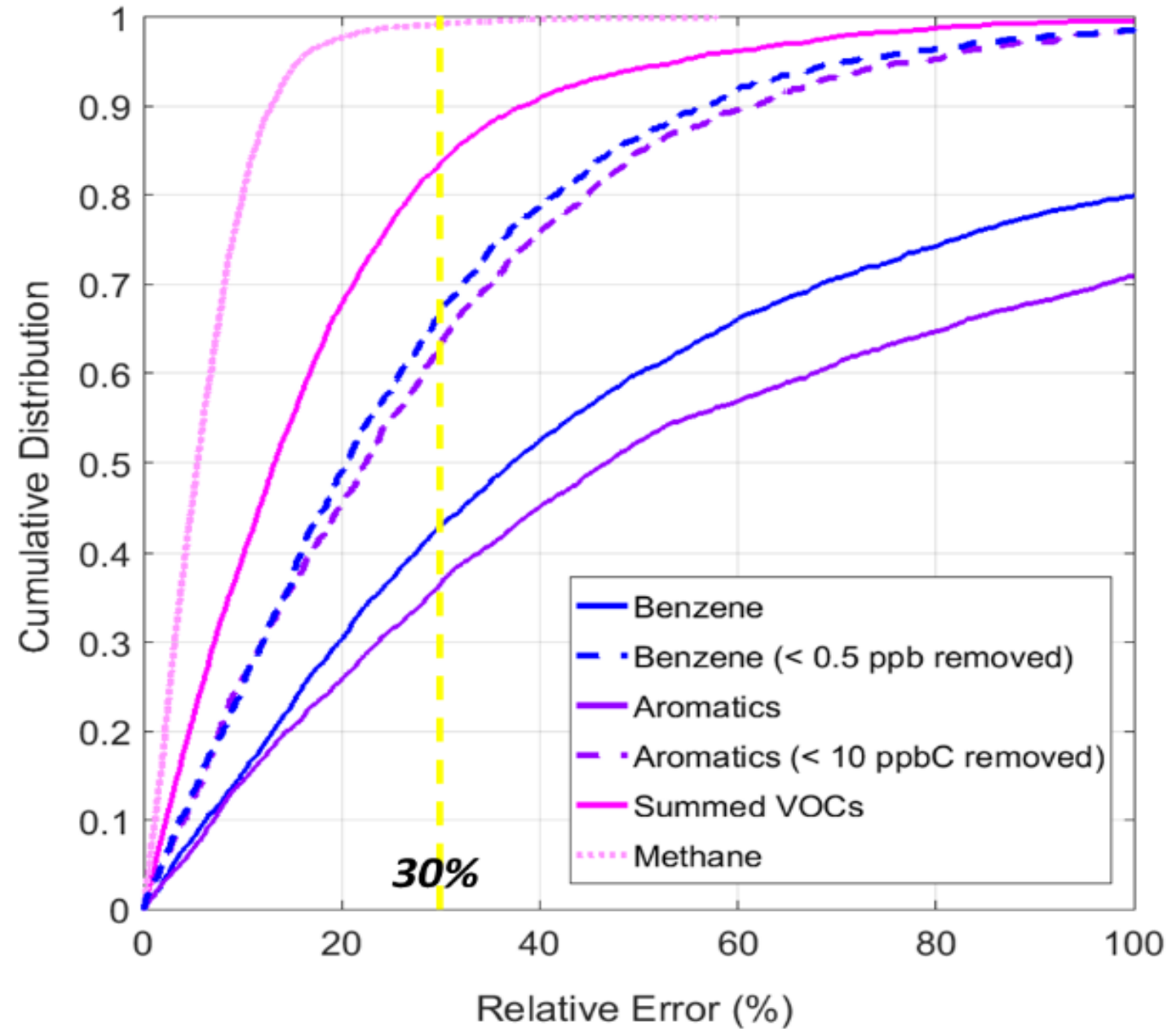
	<i>Training</i>			<i>Testing</i>		
	R²	RMSE	MB*	R²	RMSE	MB
Single Sensor – CH ₄ (ppm)	0.812	0.153	0.001	0.737	0.178	0.025
Multi Sensor – CH ₄ (ppm)	0.880	0.111	0.000	0.802	0.157	0.074
Multi Sensor – NMHC (ppb)	0.598	31.15	0.011	0.458	46.35	7.62

Digger deeper into sensor arrays for VOCs

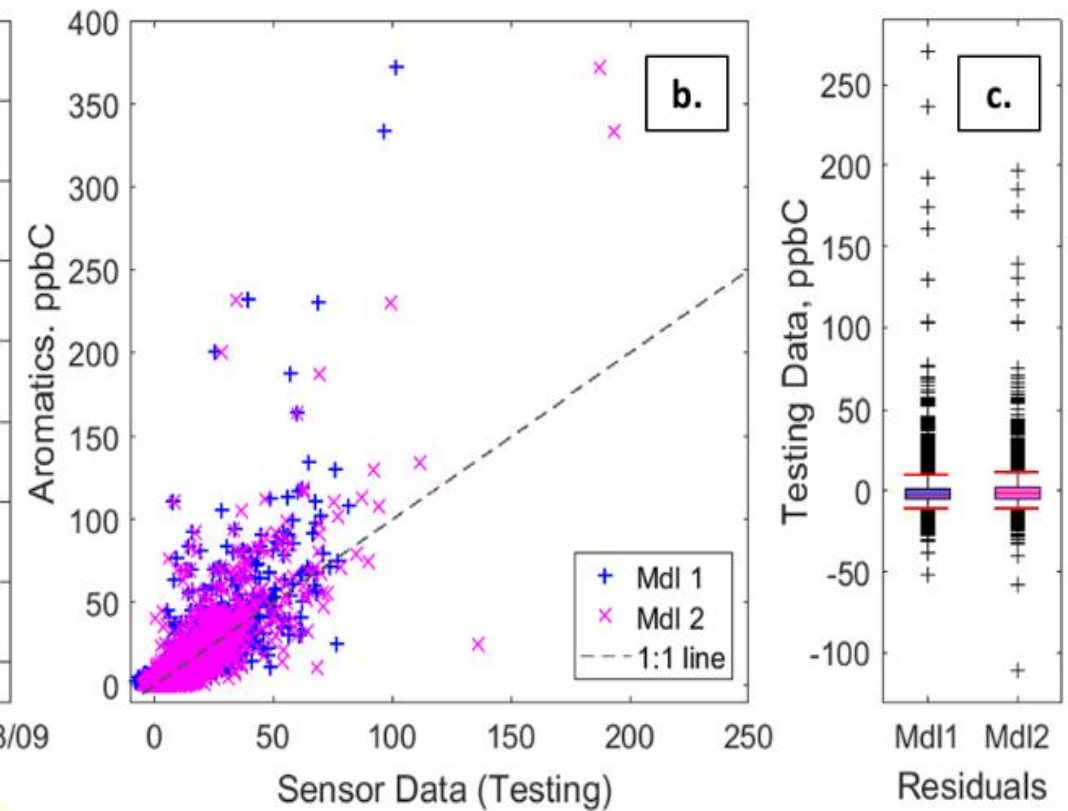
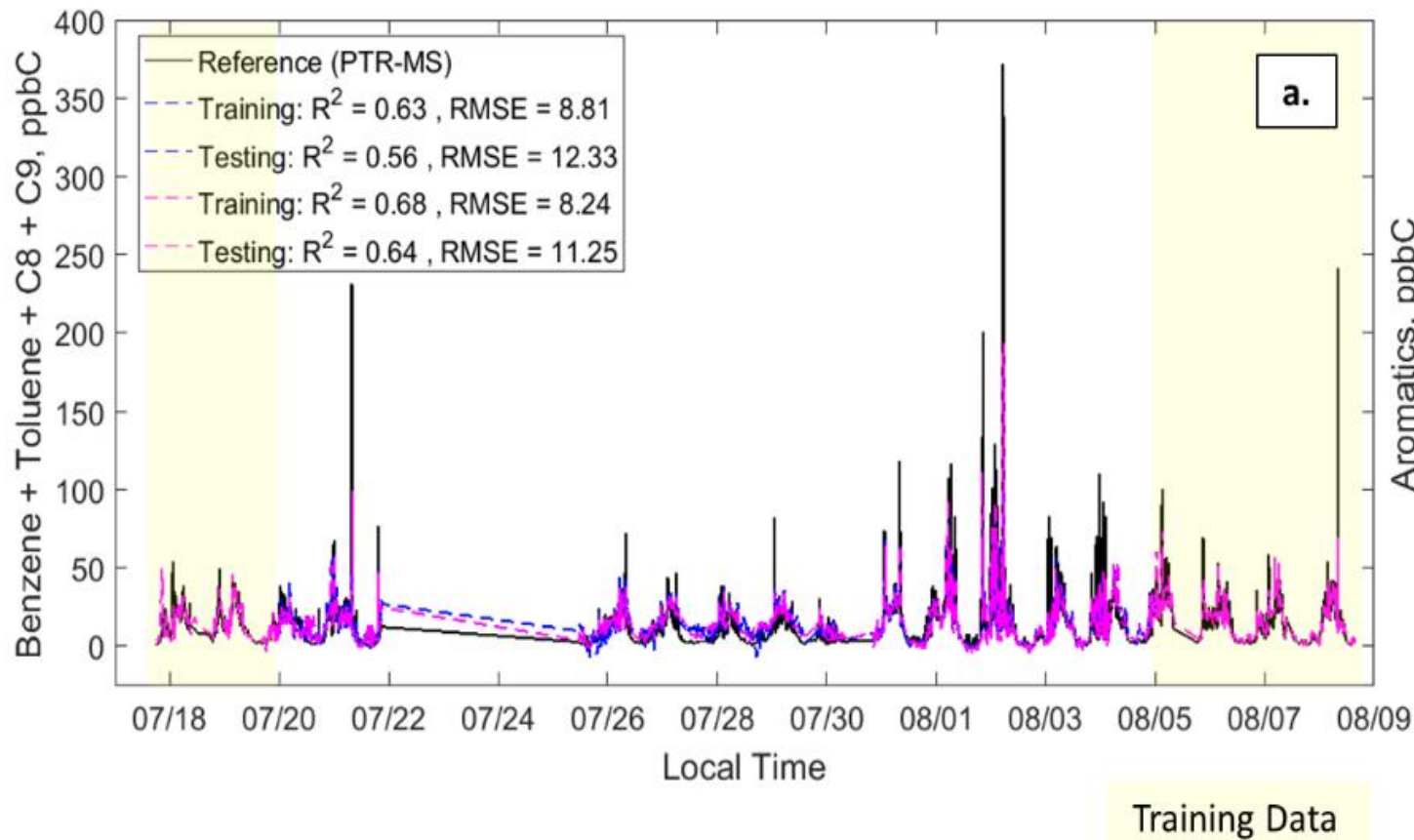


Work recently submitted to Atmospheric Measurement Techniques

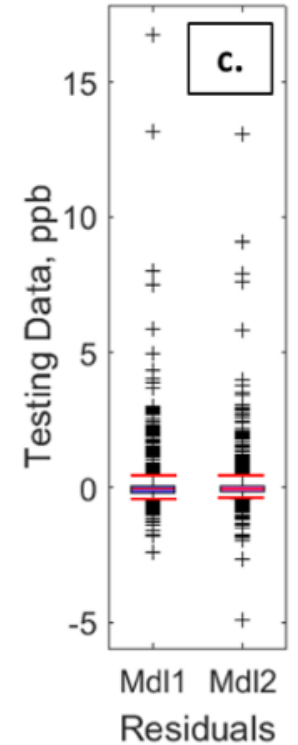
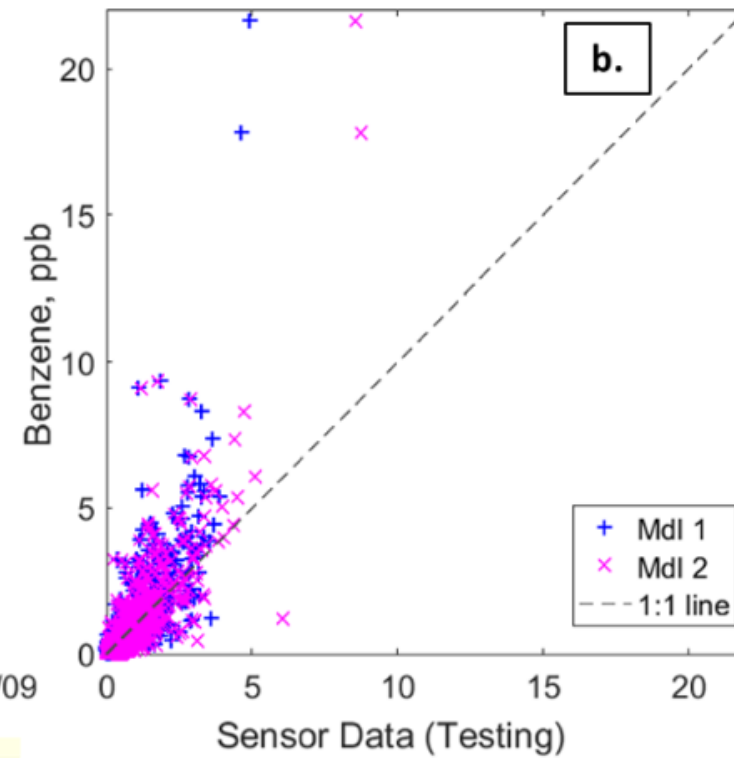
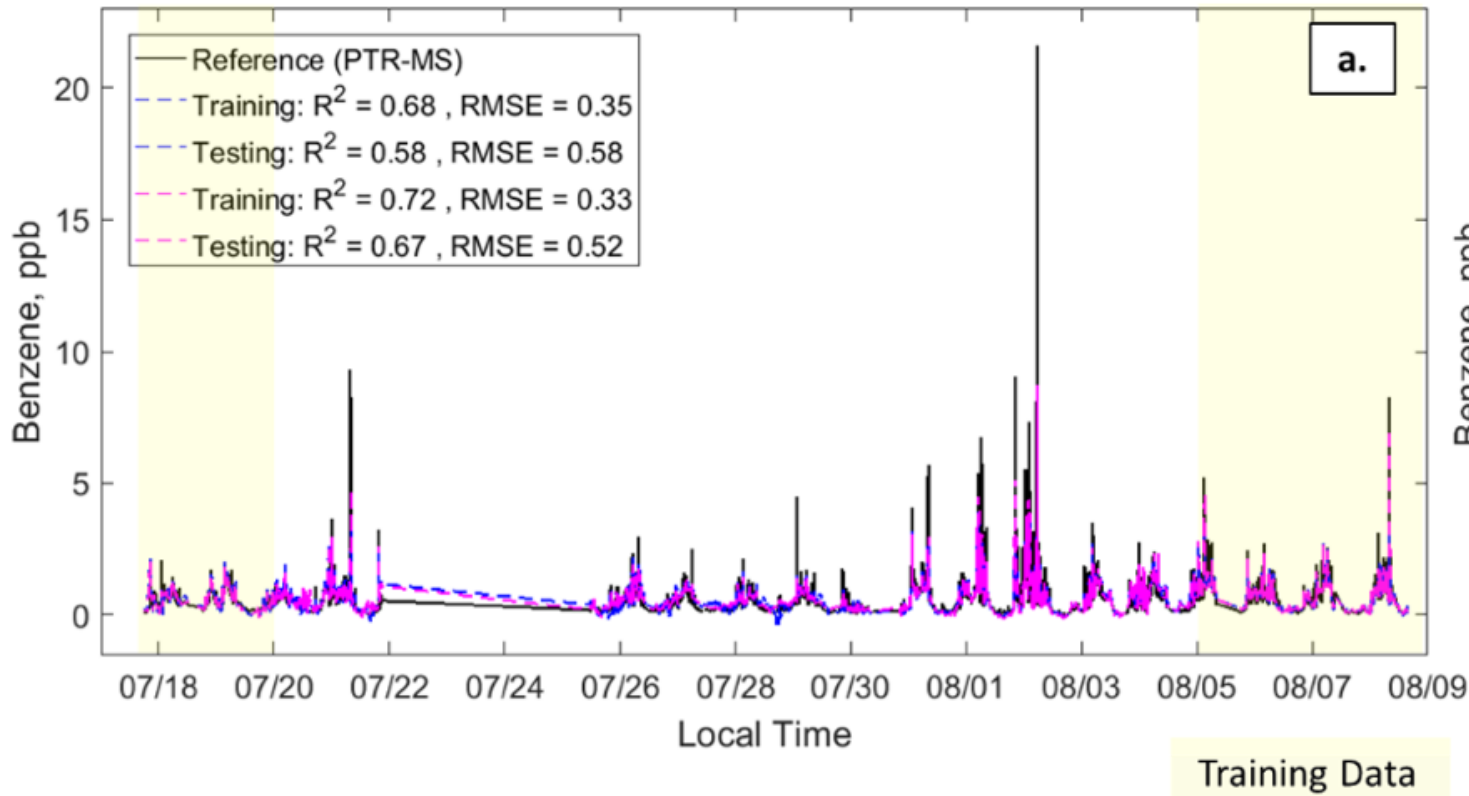
Performance DQO ...



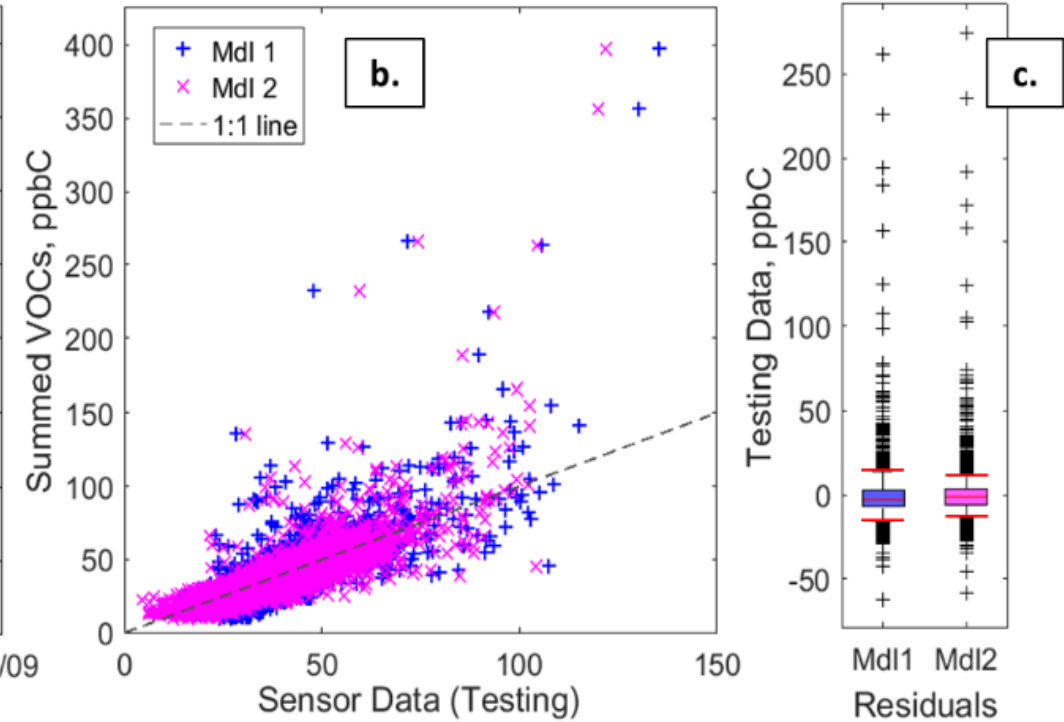
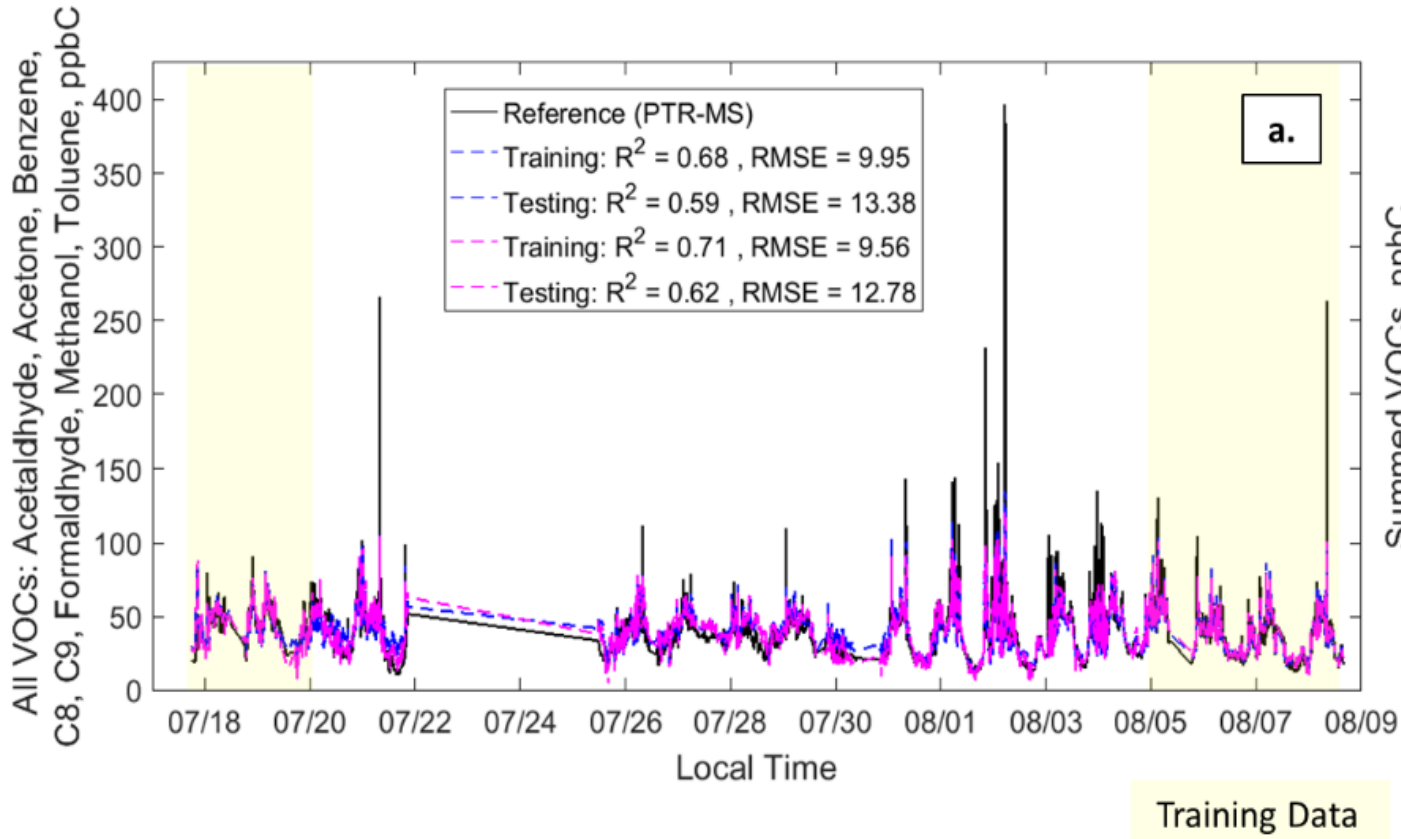
How well can the simple sensor array work for aromatic VOCs?



What about just benzene?



What about a broader suite of VOCs?



How do these quantification models work when VOC mixtures change?

Is quantification model performance changing with concentrations of other species?

