The winter of our oil & gas emissions, made glorious by measurements

Seasonality **oil & gas emissions?**

Uncertainties in methane emissions

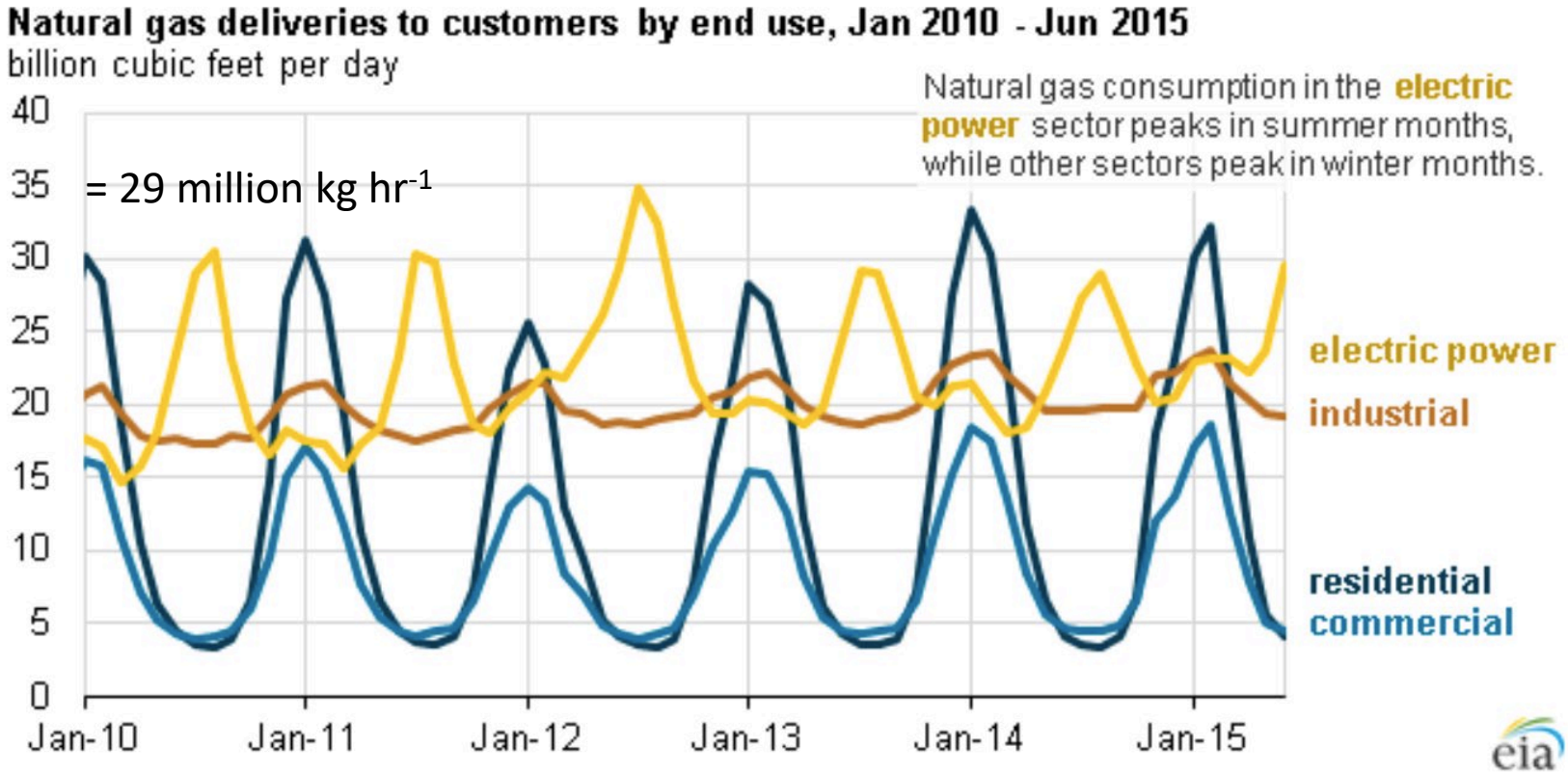
Method to quantify: tracers flux ratio

Tracers to identify emissions or air mass

Mobile lab in Western US Wintertime Study

Seasonal Natural Gas Use

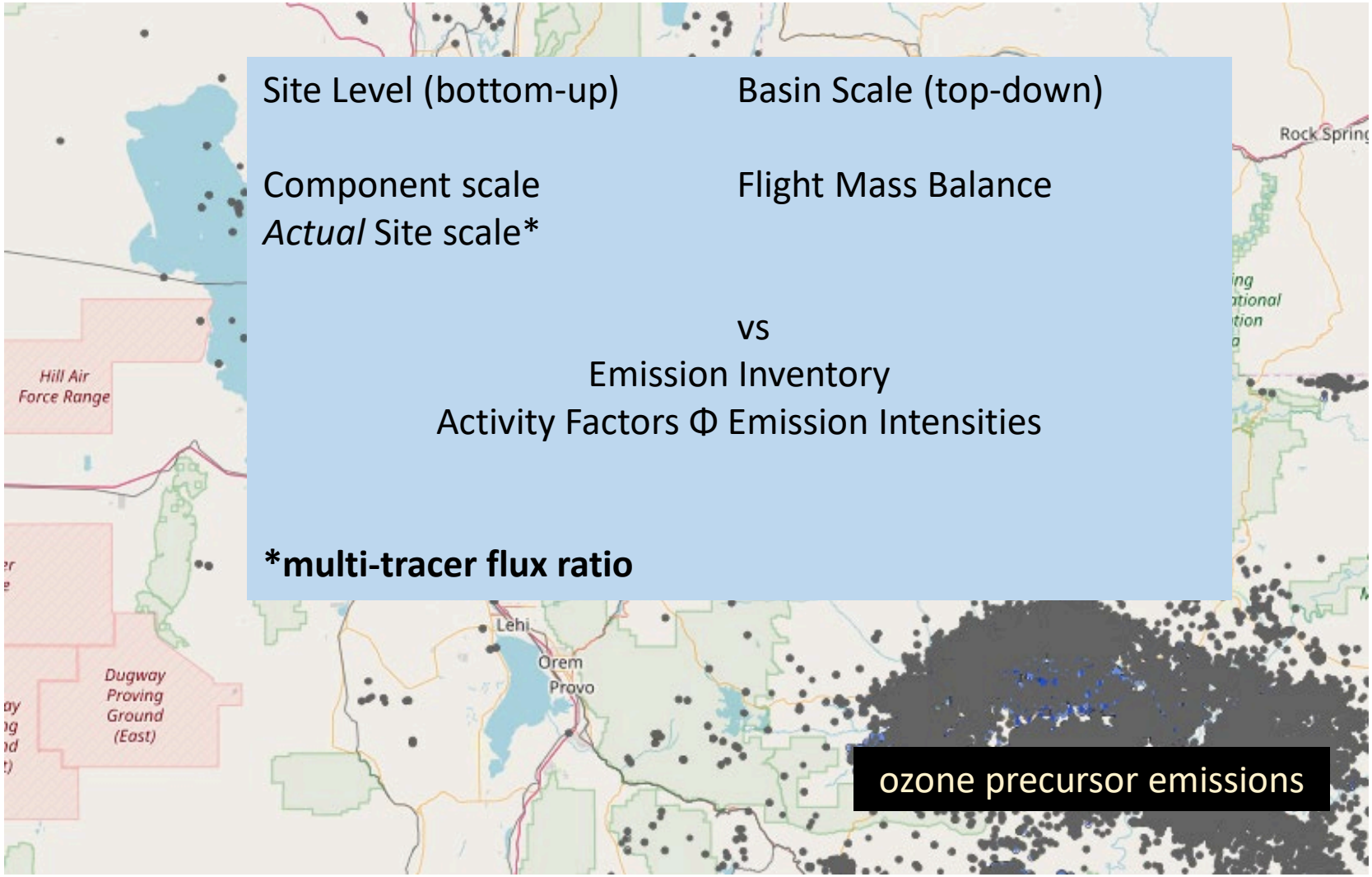
Seasonality oil & gas emissions?



Source: U.S. Energy Information Administration, *Natural Gas Monthly*
Note: Does not include natural gas as a vehicle fuel.

Anecdote: unattended production at sites with additional treatment (e.g. 'wet' gas) fare poorly in cold weather

Utah Wells



Pneumatic valves, liquids unloading, condensate tank top emissions

Aerodyne Mobile Laboratory (AML)

Instrument subset

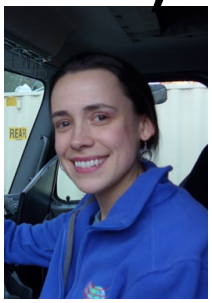
CH_4, C_2H_6, N_2O, HCN,

C_2H_2, CO_2, O_3, CO, HCHO

Vocus

HR-AMS

Conner Daube

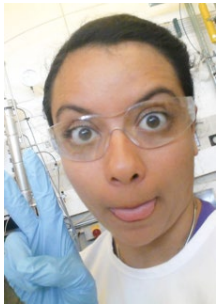


Tara Yacovitch

Rob Roscioli

Jordan Krechmer

Christoph Dyroff



Francesca Majluf

Scott Herndon

Jason Curry

Bill Long

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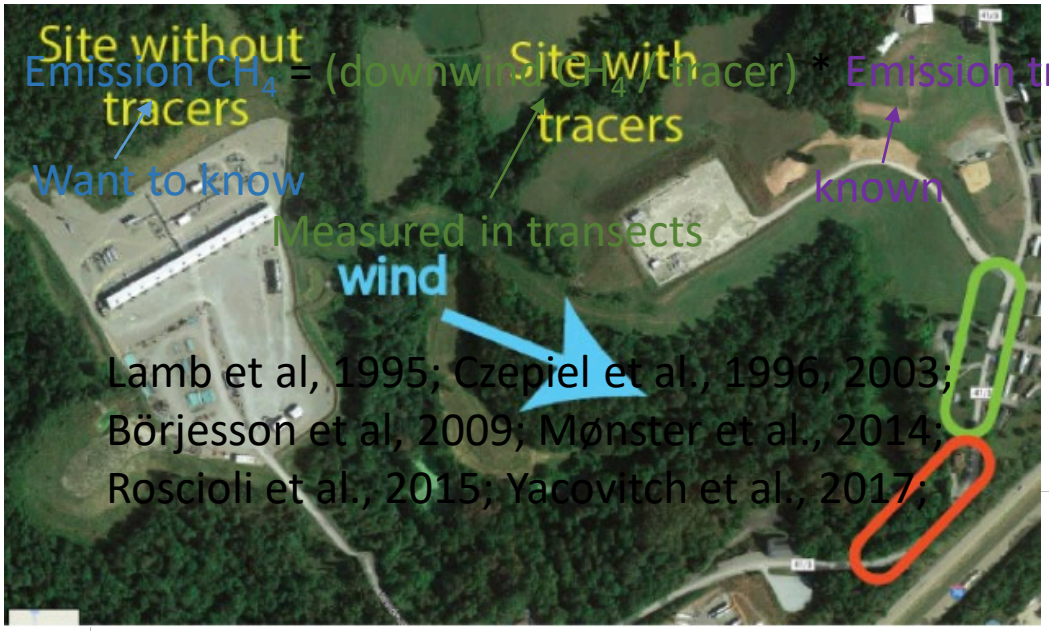
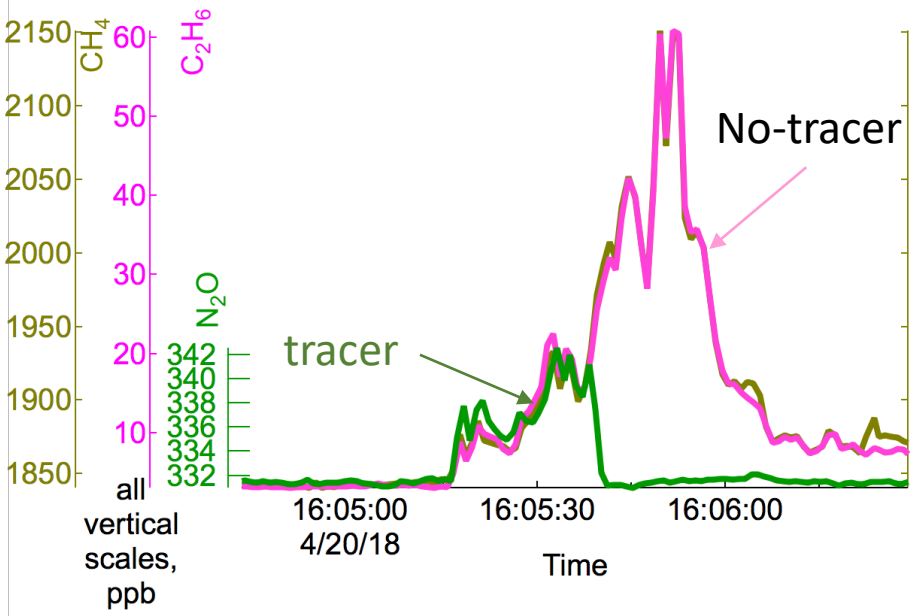
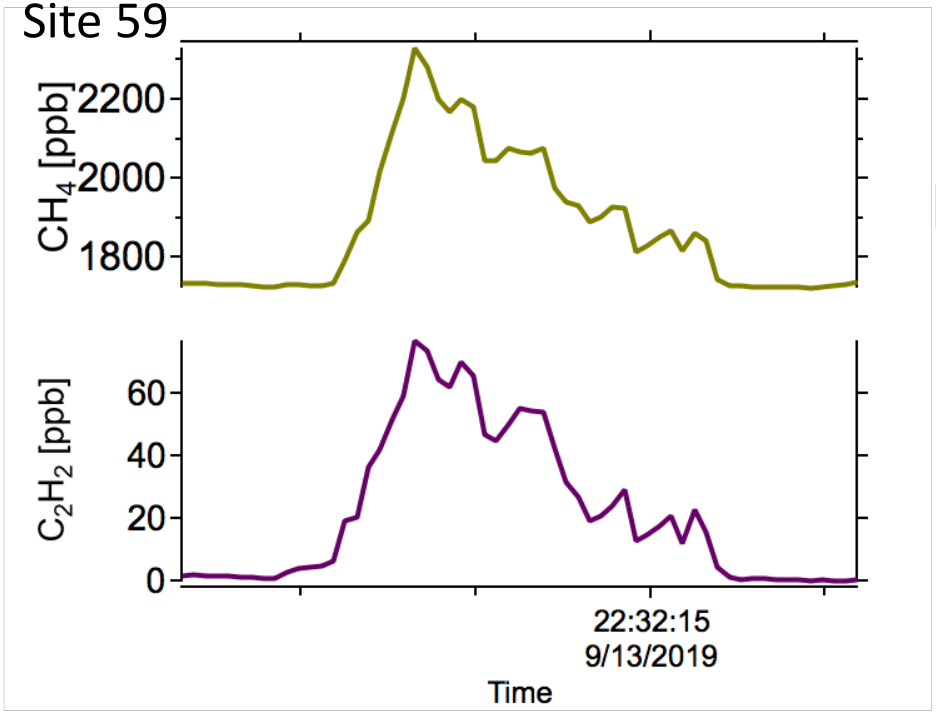
Industrial Emissions Characterization

Method to quantify: tracers flux ratio







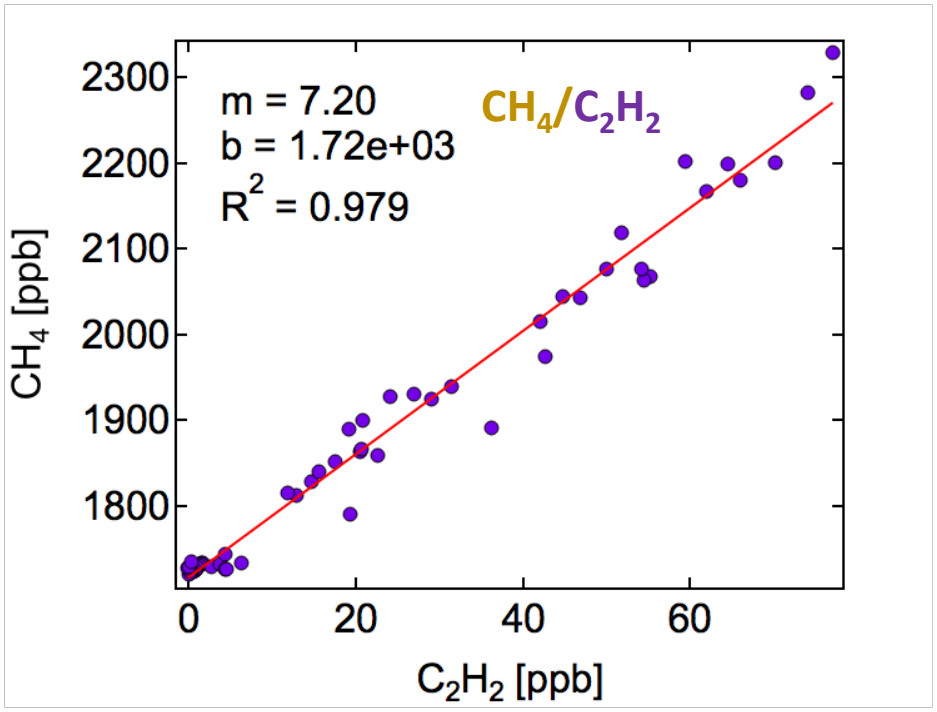
Method to quantify: tracers flux ratio

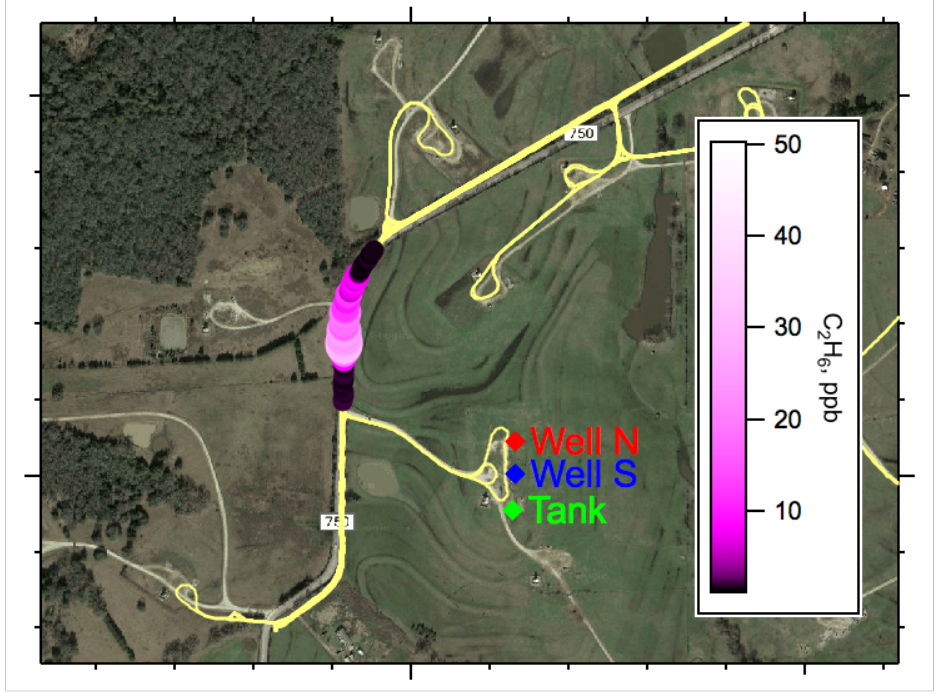
Methane Emission Rate

$$F(CH_4) = CH_4/C_2H_2 \times F(C_2H_2)$$

$$F(CH_4) = 7.2 \times F(C_2H_2)$$

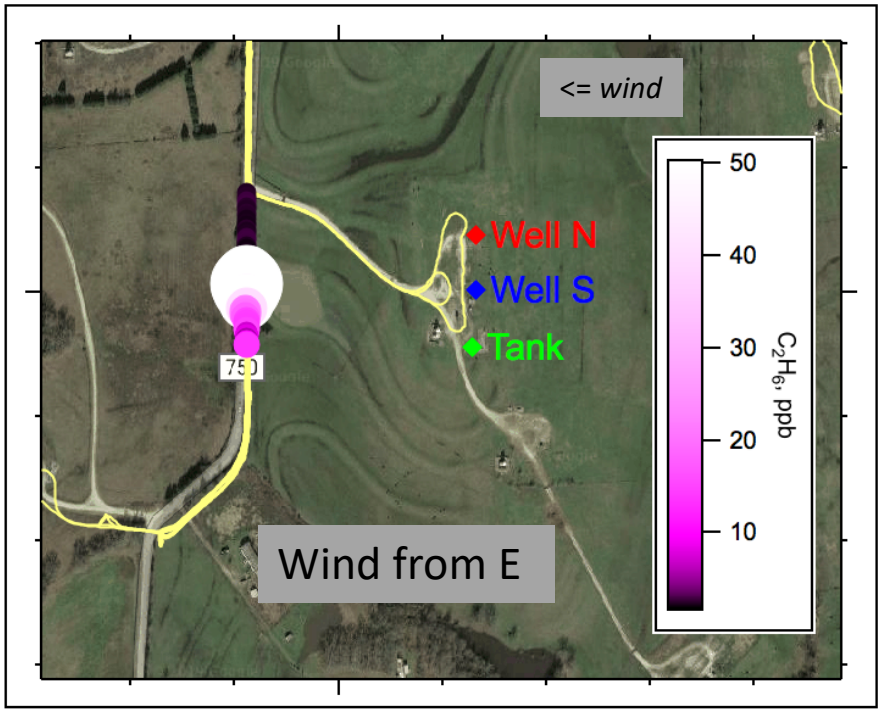
"dry gas" region
Texas
September 2019





Site ID 59

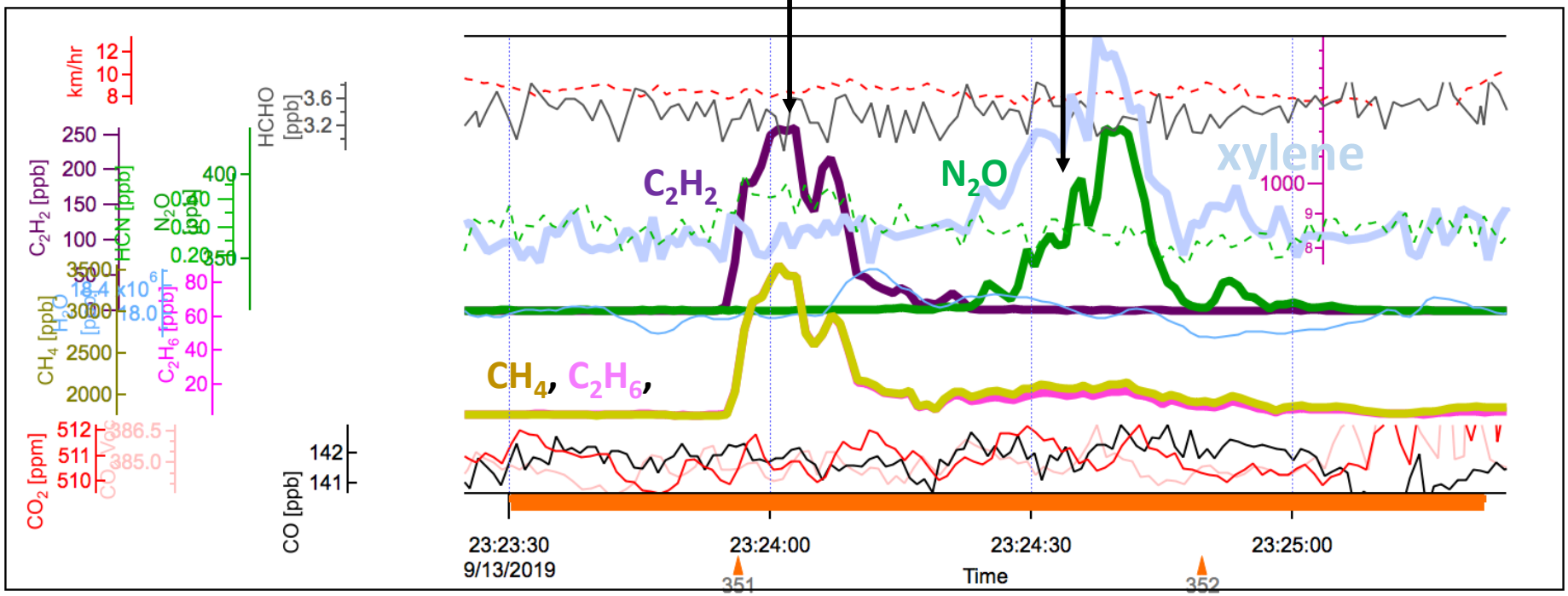
The dominant source at this site is the north well (with an unusual sounding pneumatic). The second well is emitting much less. The tanks are also emitting, with aromatics.



Tracer at Well N

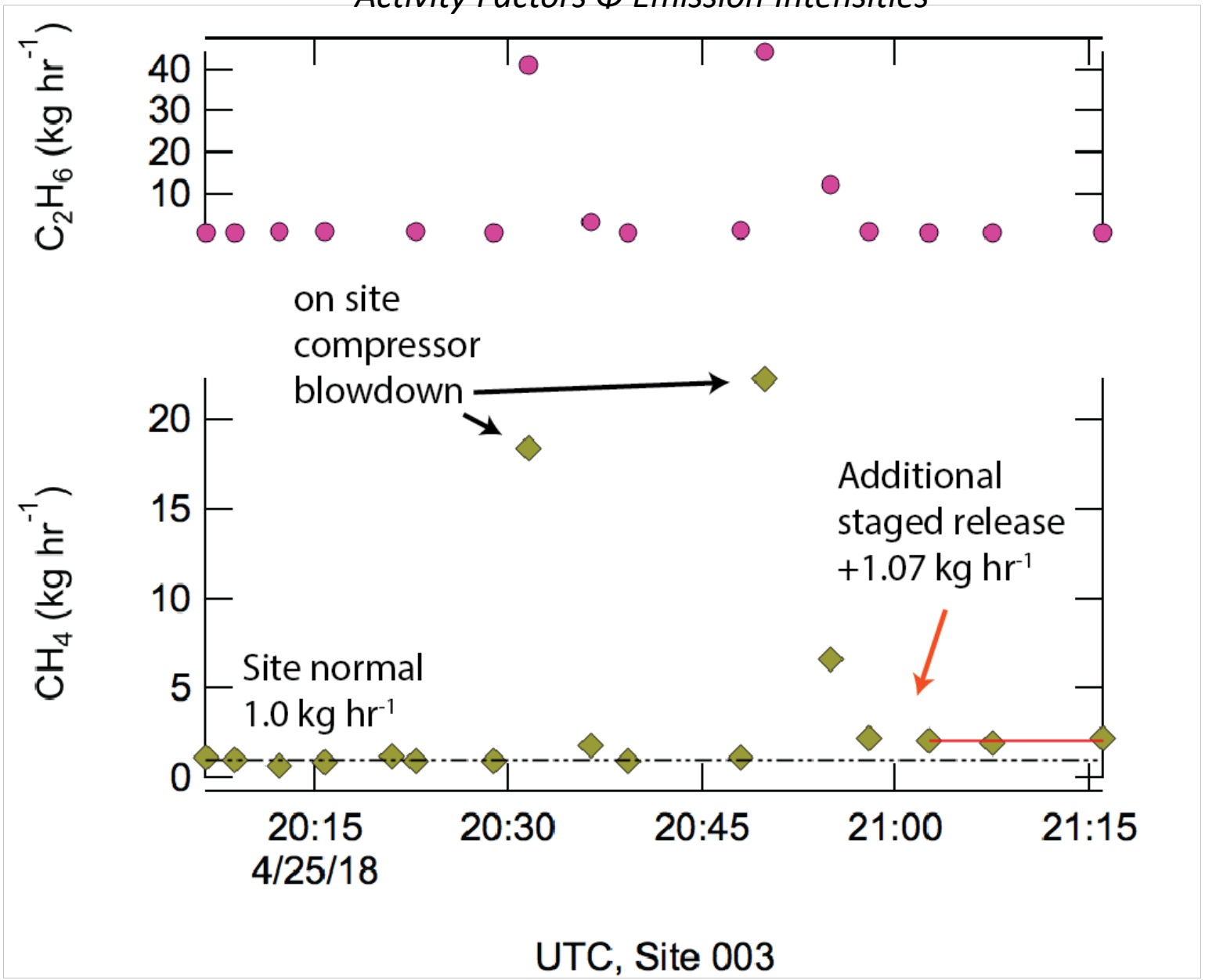
With unusual sound

Tracer at Tank



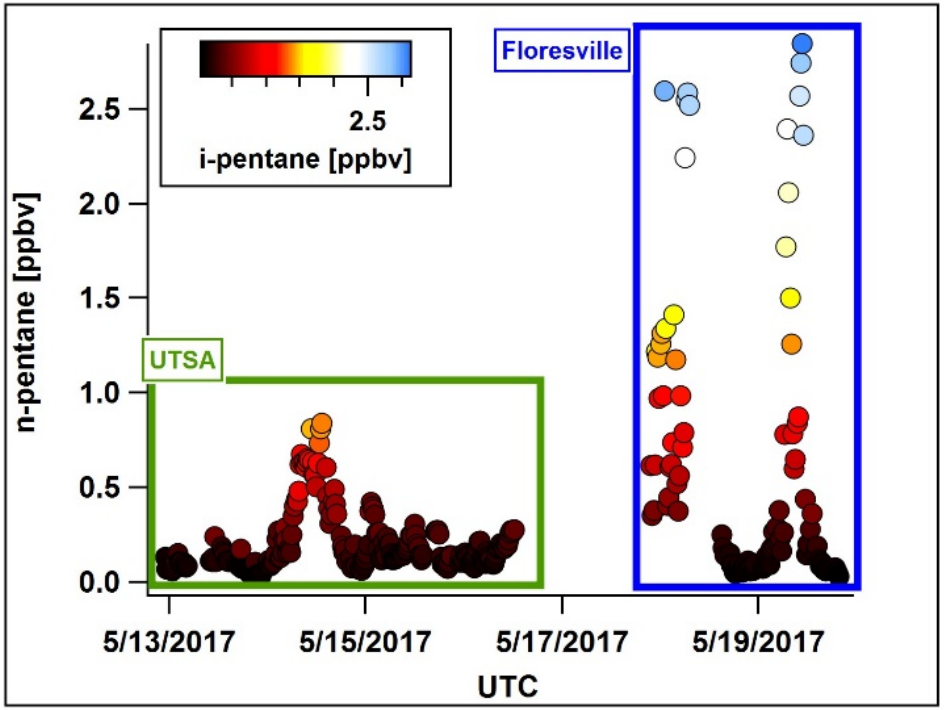
Emission intensity linked to on-site activity

Activity Factors Φ Emission Intensities

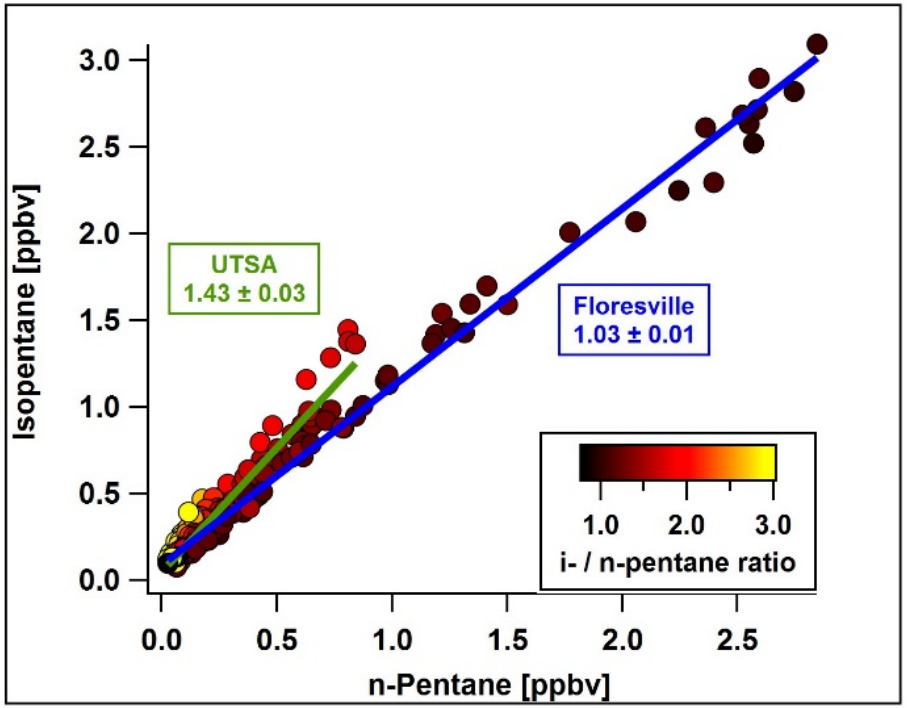


Tracers to identify emissions or air mass

Like the deliberate ‘tracers’ the chemical dimension brought by other measurements enhances CO_2, CH_4, N_2O measurements



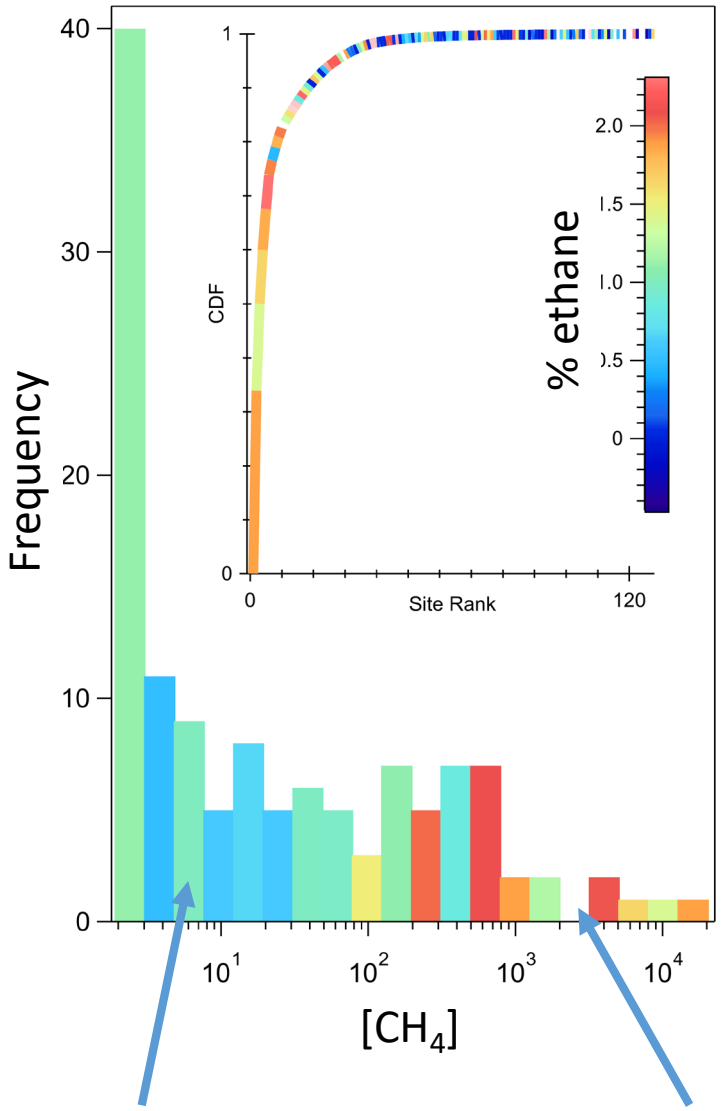
i-pentane and n-pentane mixing ratios observed during Texas AQRP 2017



Ratio of iso- to n-pentane mixing ratio for two sampling sites.

Inspired by -> Observed iso- and n-pentane mixing ratios at various sites in Colorado and two cities (Houston, TX and Pasadena, CA).[*Gilman et al.*, 2013]

Example of urban source attribution: Boston manhole CH_4 *and* C_2H_6 concentrations



- Ethane content provides information about the sources (biogenic vs NG) in urban settings
- Manholes with high CH_4 are dominated by natural gas, *not biogenic "sewer" gas*

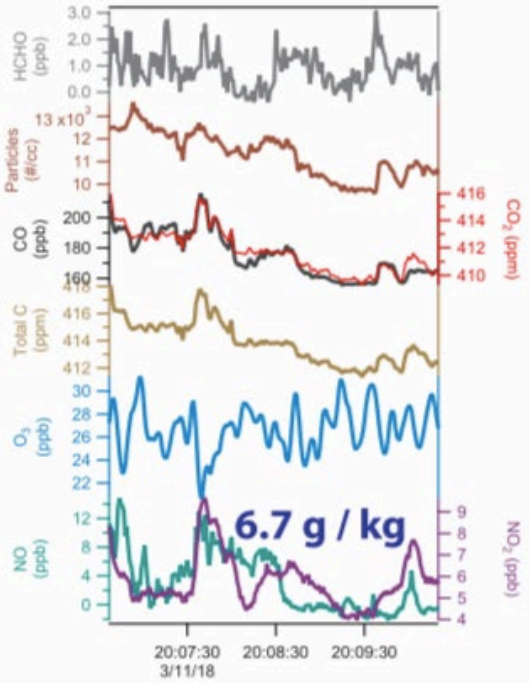
Manholes with low methane content have low and high ethane content

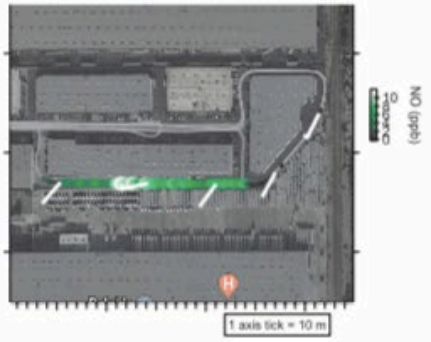
Manholes with high methane content ***also*** have high ethane content

Like the deliberate ‘tracers’
the chemical dimension brought by other measurements enhances CO_2, CH_4, N_2O measurements

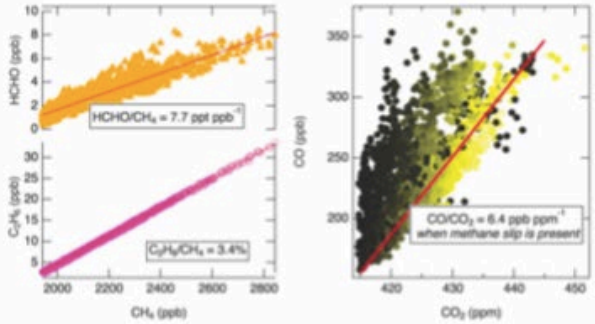
Tracers to identify emissions or air mass

NOx at Truck Depot





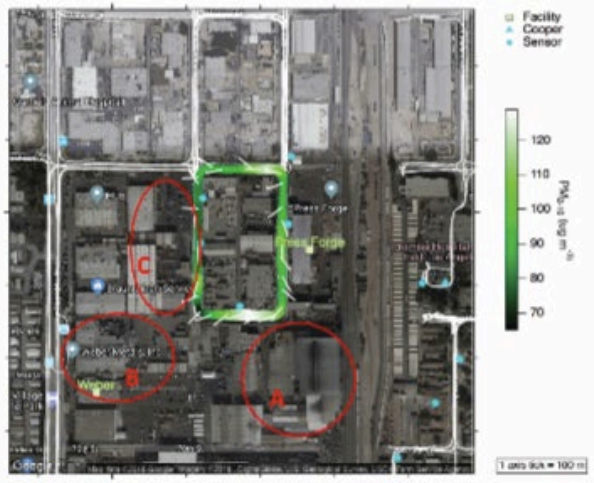
Natural Gas Forge



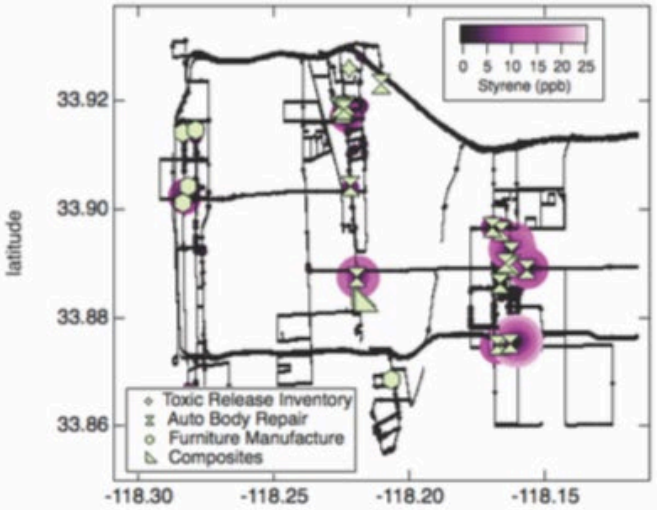
Furnace Slip

HCHO = 7.7e-3 CH_4

C_2H_6 = 3.4% CH_4

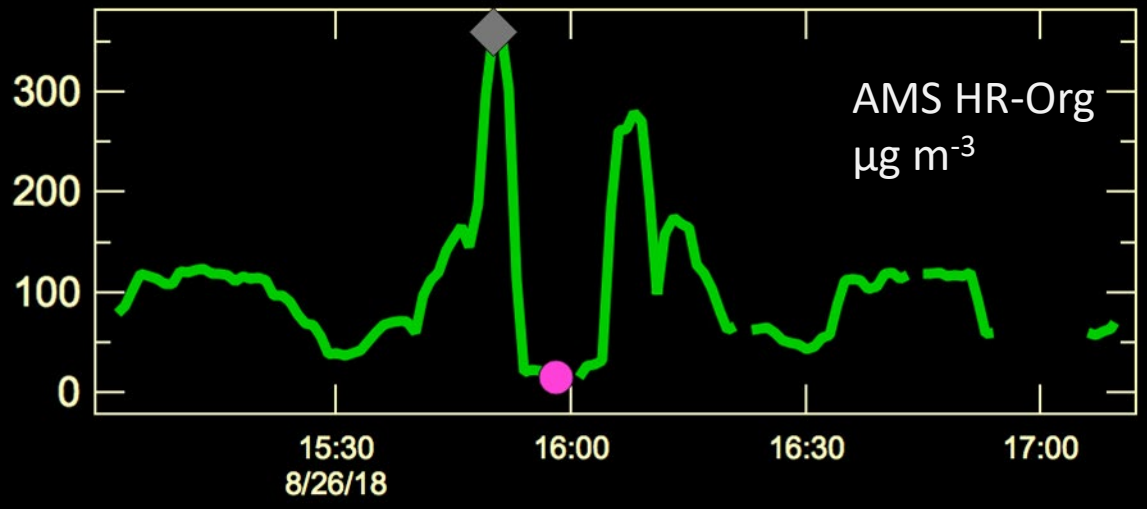


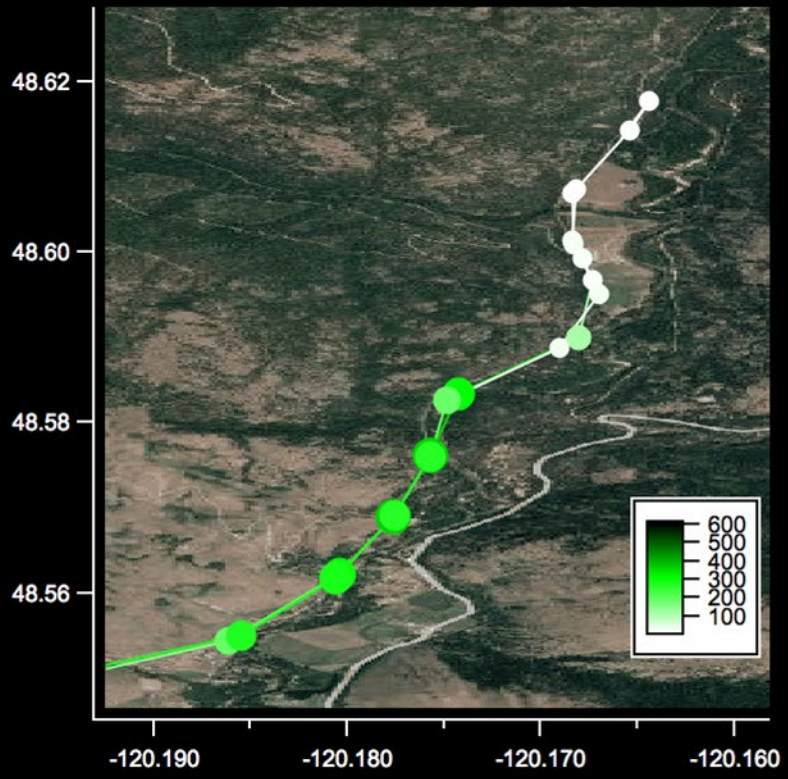
Styrene Hot-Spots



Inventory and detected hot-spots agree

auto-body & furnature manufacture



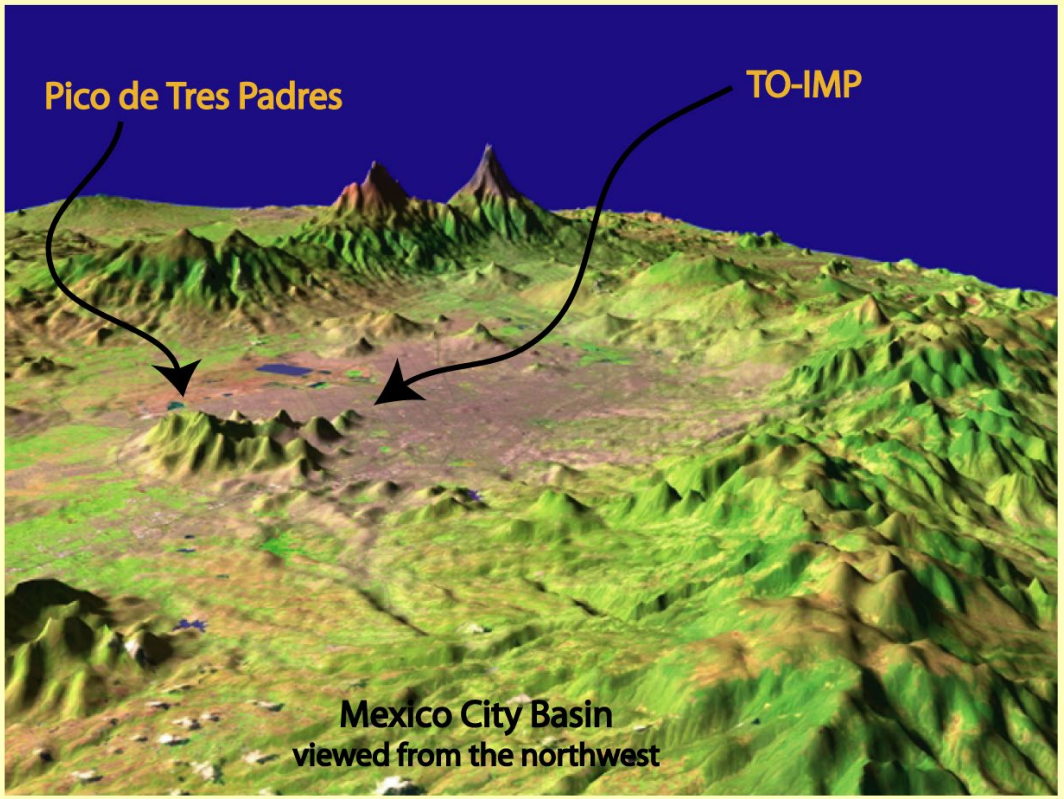


Mobile ground measurements resolve substantial changes in atmospheric composition

Relevant to wintertime vertical gradients in SLC

NOAA FIREX - 2018

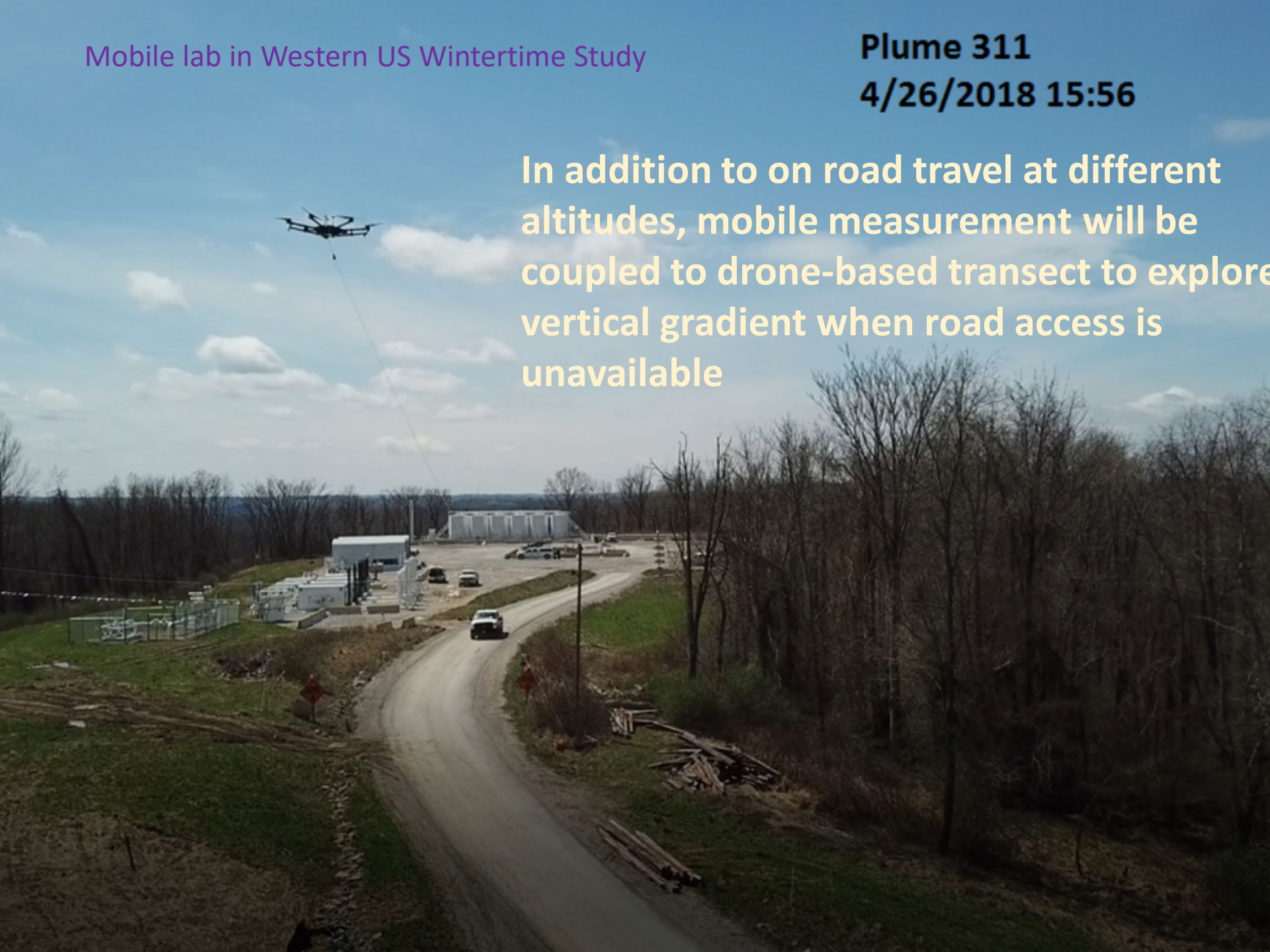
Using topography to advantage



Mobile Lab can measure within an urban boundary layer and quantify the residual layers above by using topography

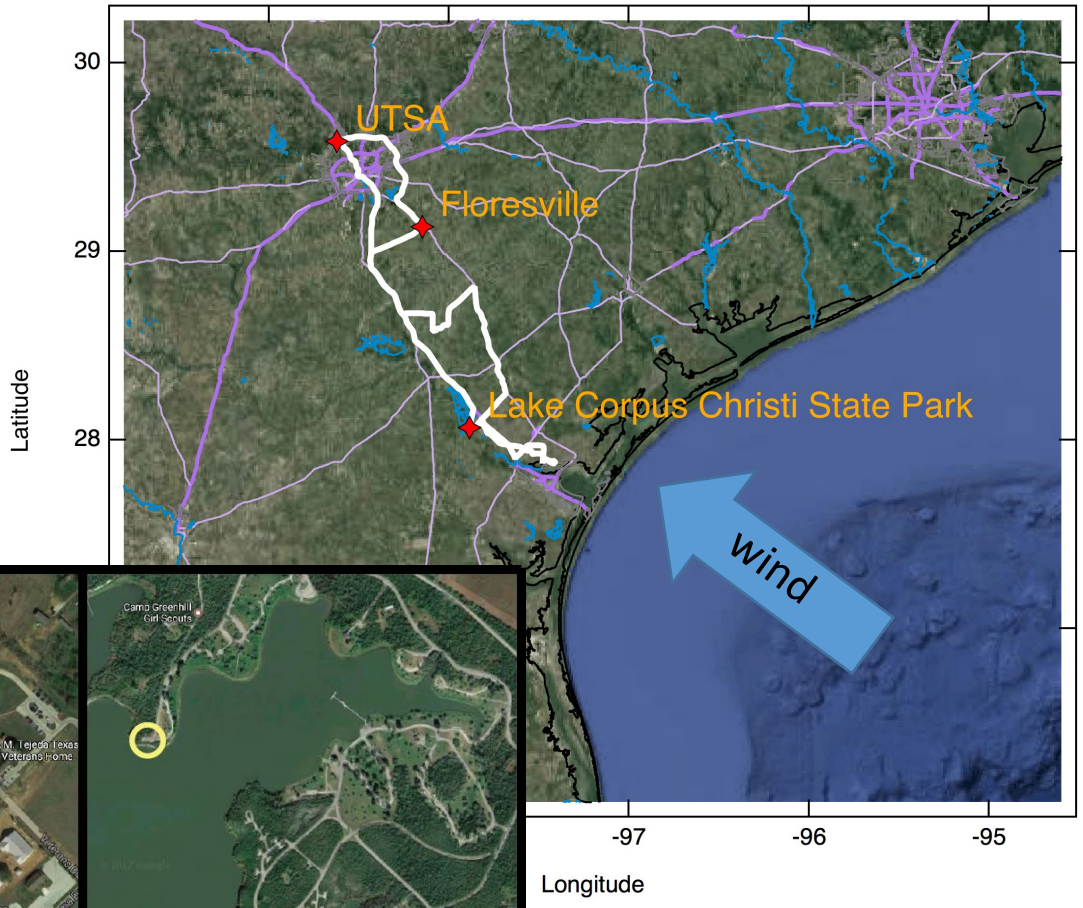
DOE/NSF Milagro 2006

Mobile lab in Western US Wintertime Study



Identifying and Apportioning Ozone Producing Volatile Organic Compounds in Central Texas

Aerodyne Research, Inc.
Drexel University
Montana State University
Environment Canada
University of Texas (Austin/San Antonio)
University of Houston
Baylor University



University of Texas, San Antonio | Floresville TCEQ Monitoring Site | Corpus Christi State Park

AQRP
May 2017

Summary

Seasonality oil & gas emissions?

Yes and no

Uncertainties in methane emissions

on-site activity factors & emissions with research endeavor can match top-down

Method to quantify: tracers flux ratio

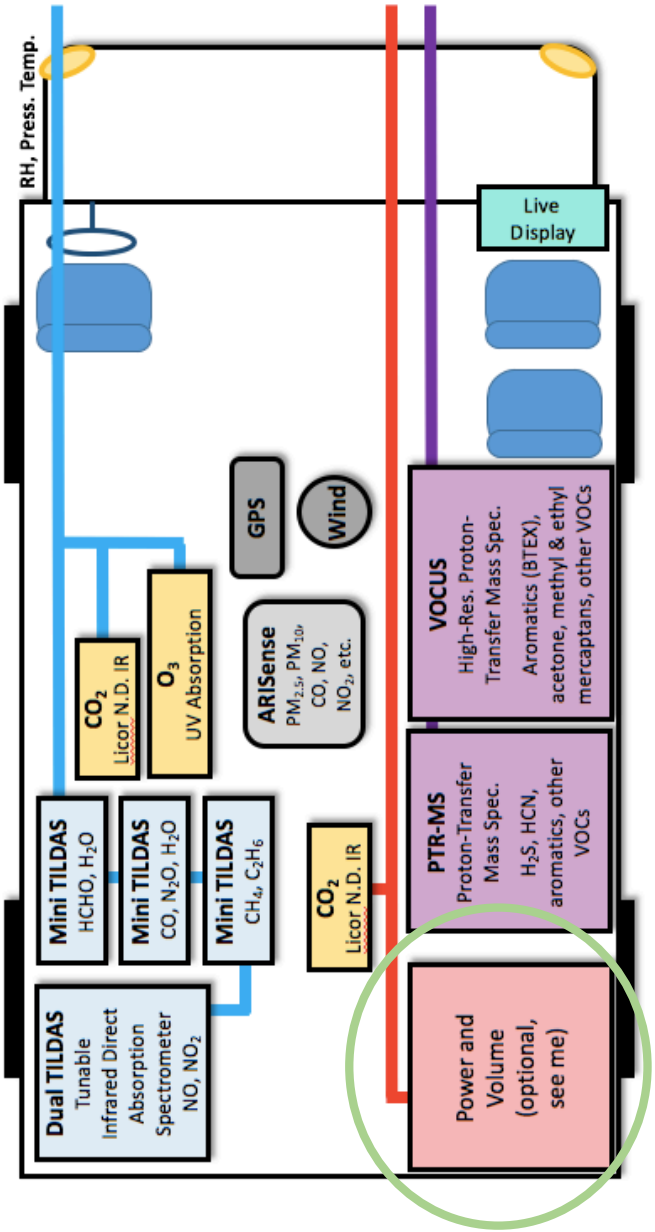
on-site/whole-site can be quantified

Tracers to identify emissions or air mass

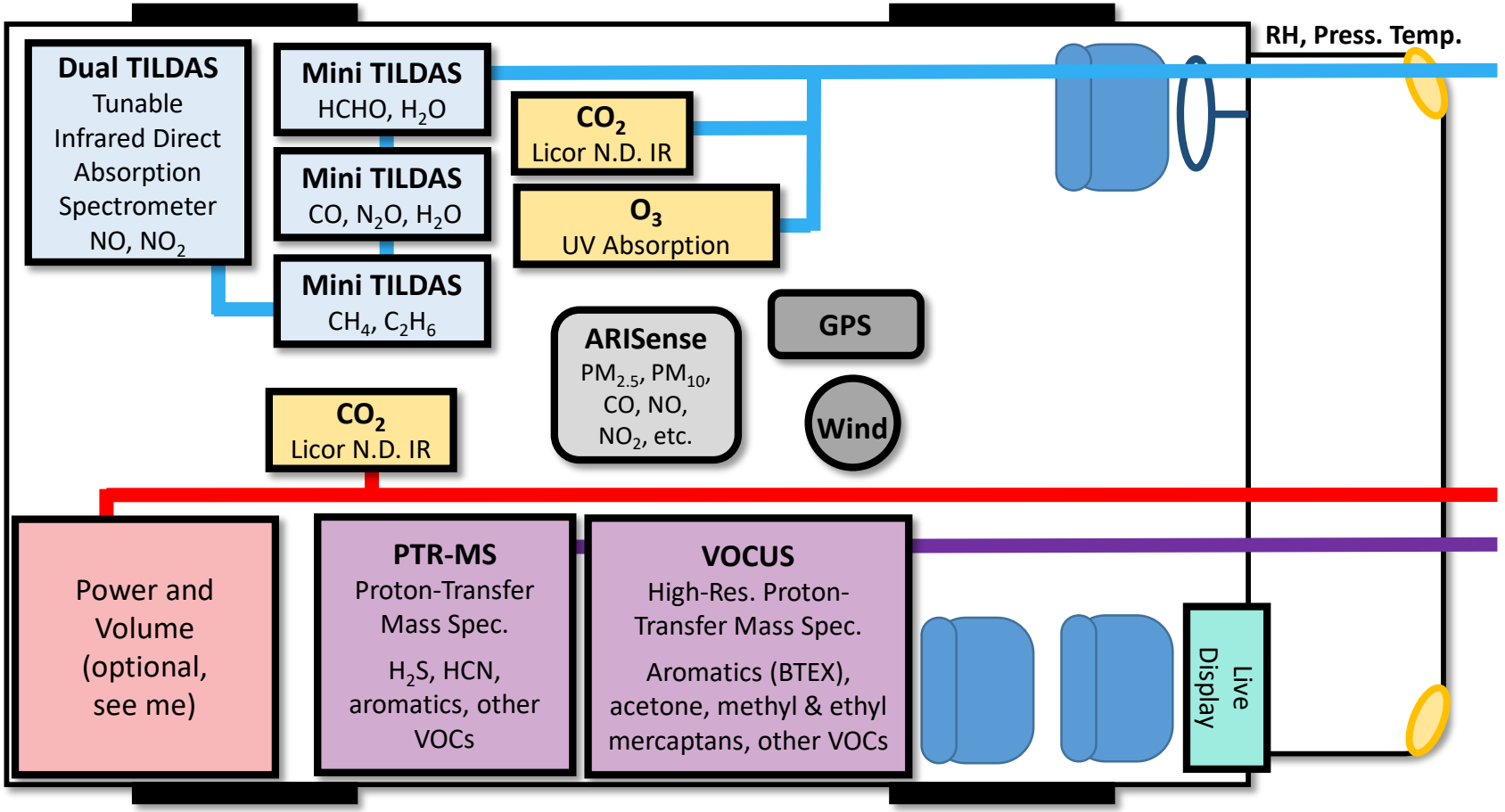
chemical signatures are inherent ‘tracers’

Mobile lab in Western US Wintertime Study

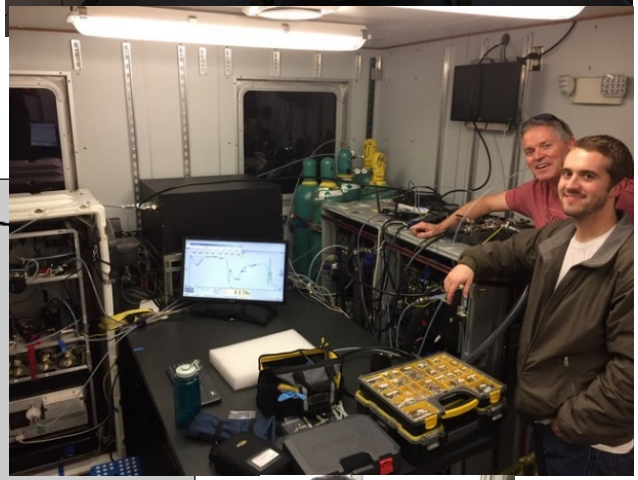
AML could be used to look at spatial and vertical composition gradients

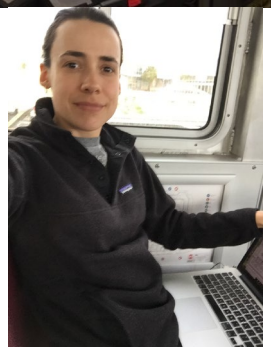


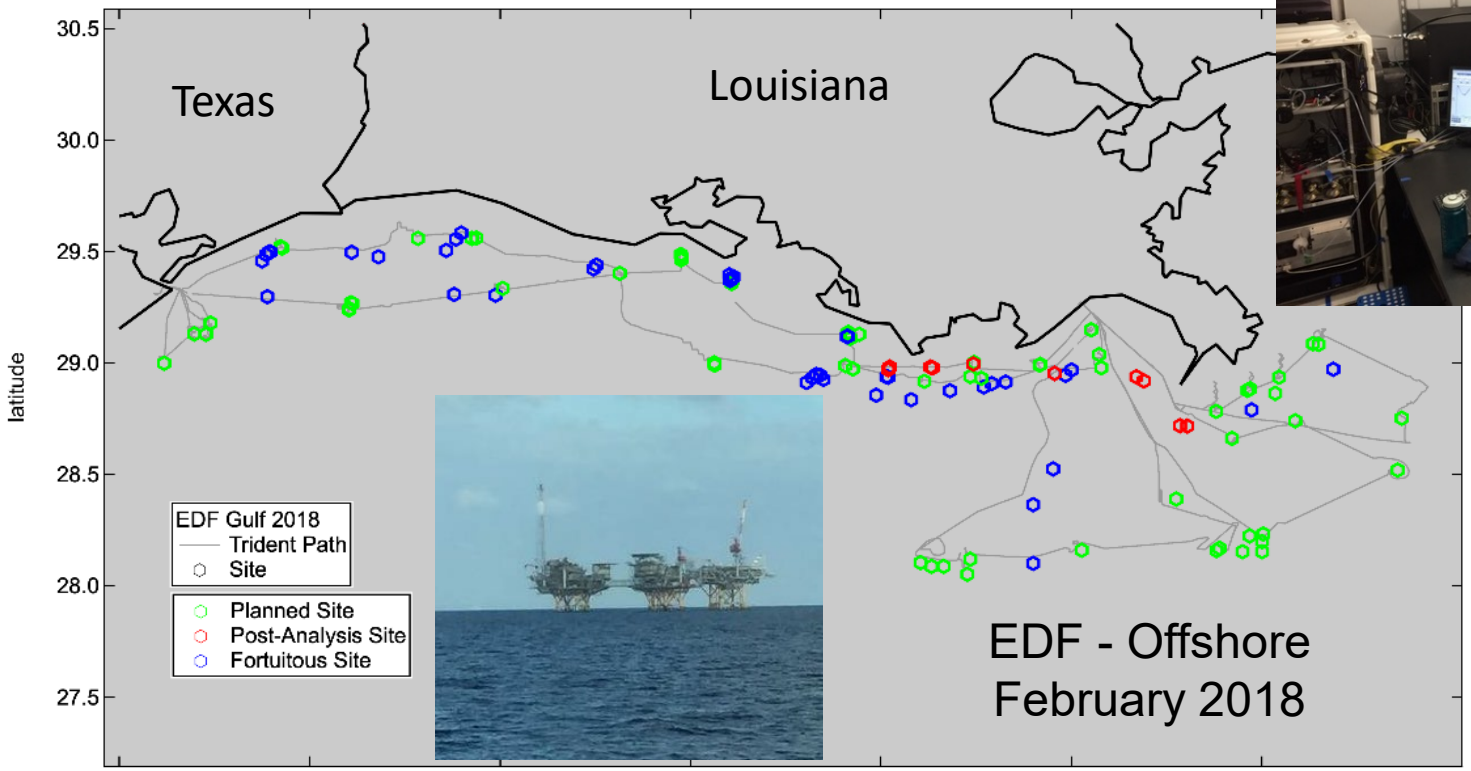
AML Schematic, 2019



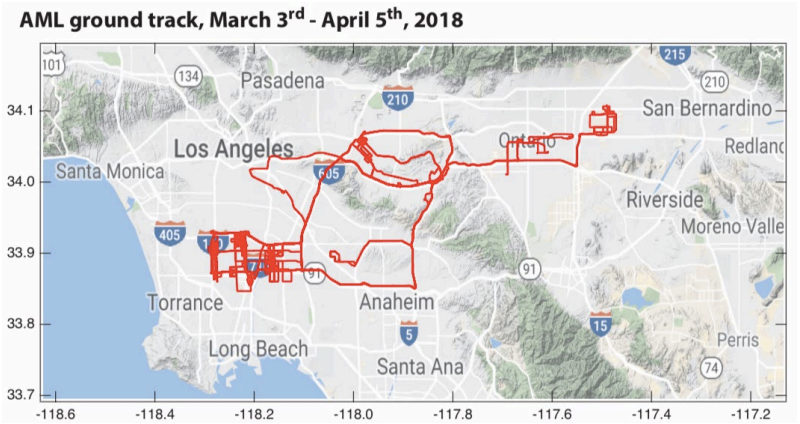
Environmental Defense Fund Offshore



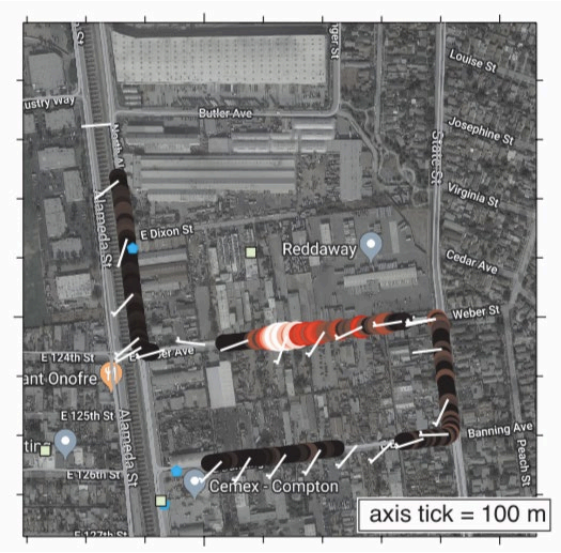




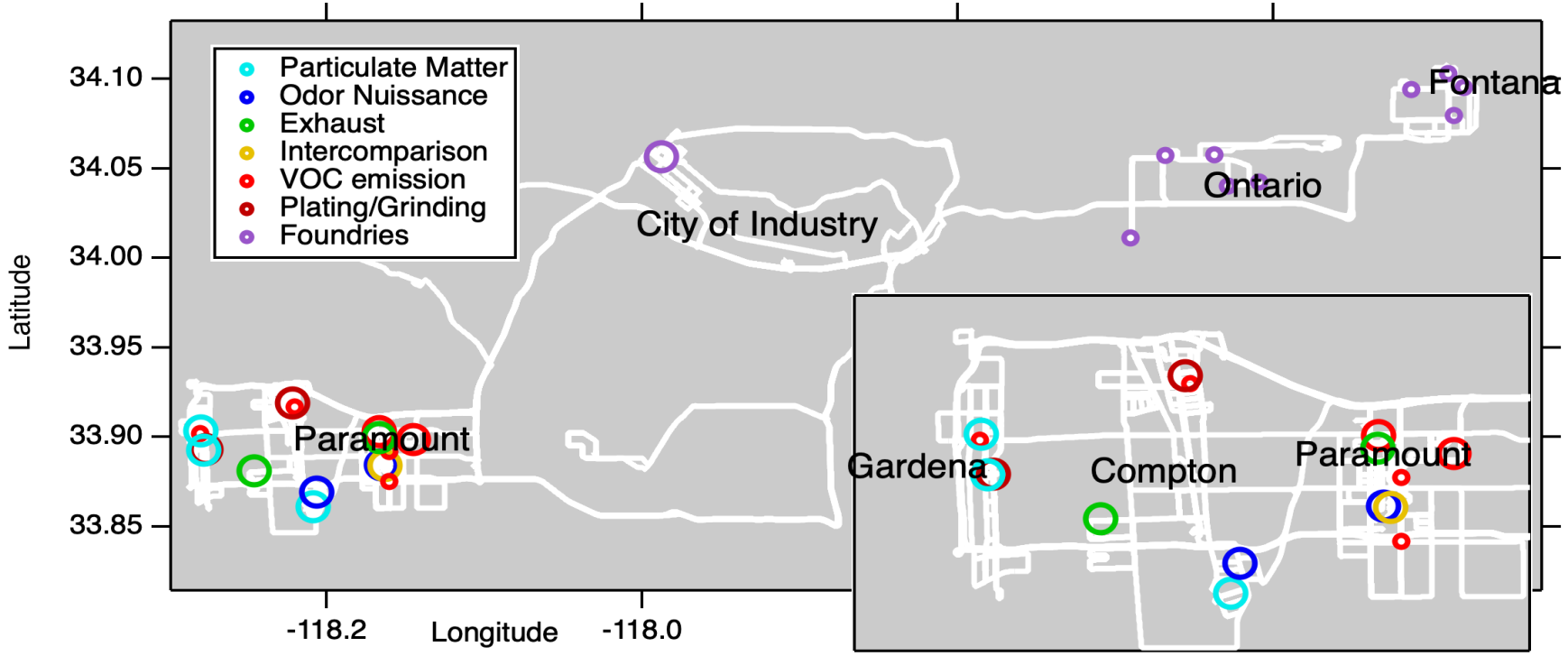
Industrial Emissions Characterization



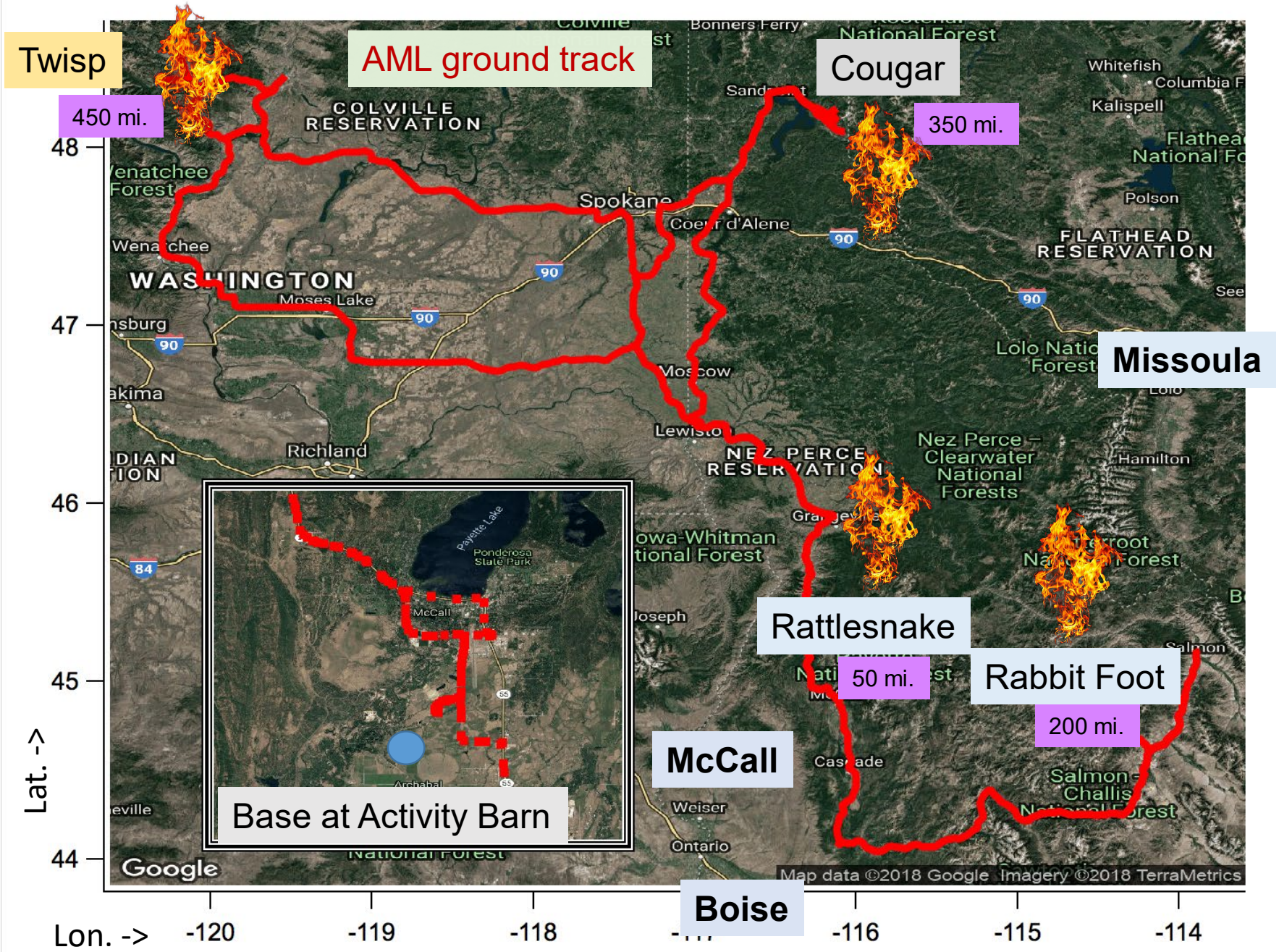
South Coast Air Quality Management District March 2018



Los Angeles, CA



FIREX – August, 2018 Field Deployment, Idaho & Washington



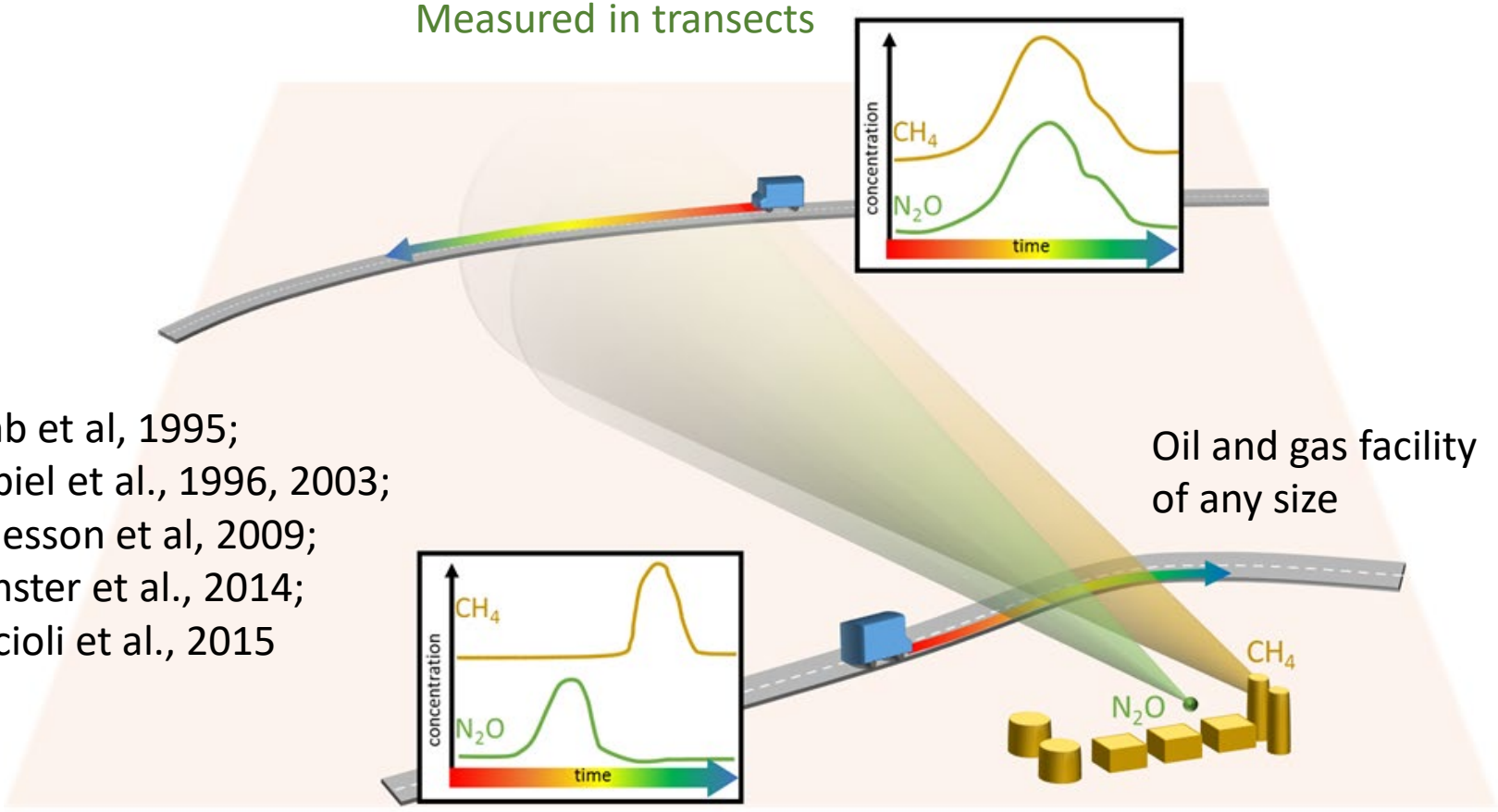
Tracer Flux Ratio *quantifies* CH_4 through correlation with tracer

Emission CH_4 = (downwind CH_4 / tracer) * Emission tracer

Want to know

Measured in transects

known

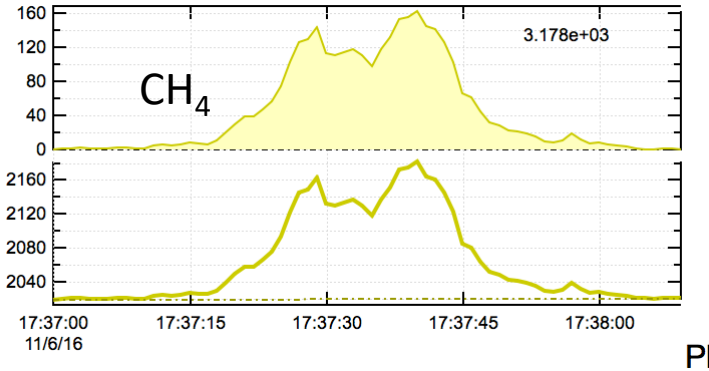


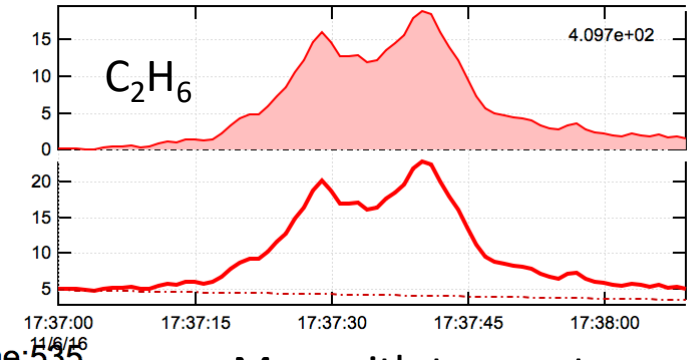
Lamb et al, 1995;
Czepiel et al., 1996, 2003;
Börjesson et al, 2009;
Mønster et al., 2014;
Roscioli et al., 2015

Oil and gas facility of any size

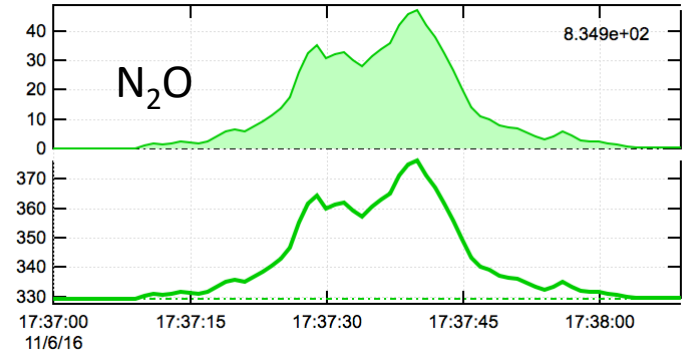
Early, this work employed one tracer, N_2O *we took single cylinder of aux. tracer* C_2H_2

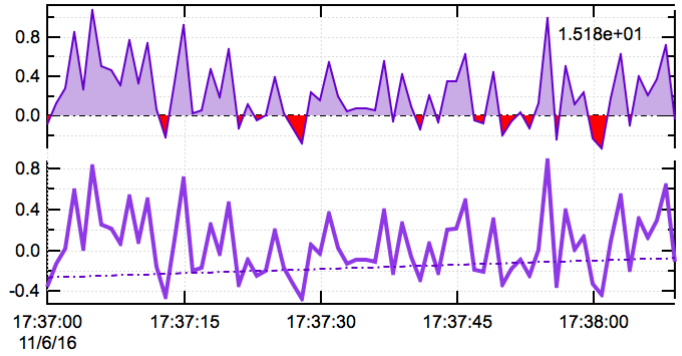
Correlated Methane and Nitrous Oxide Plumes



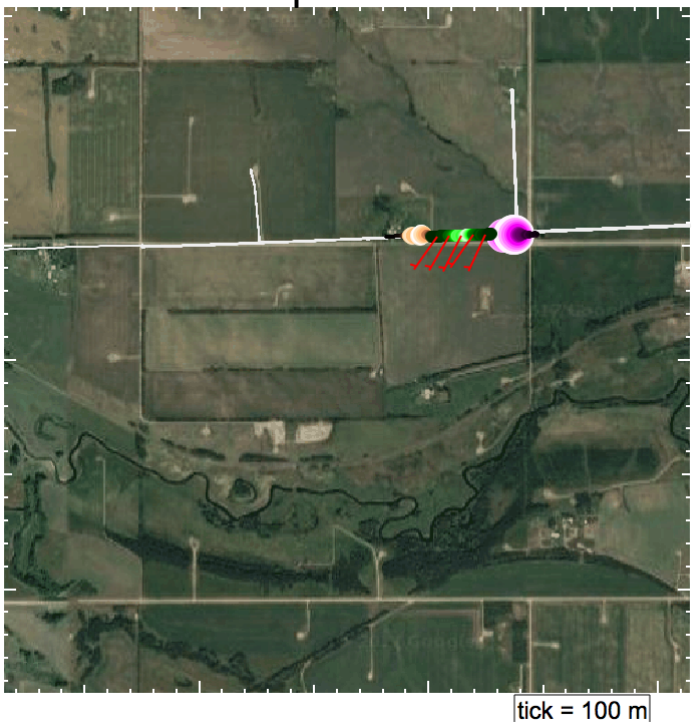


Plume:535





Map with transcect



NAL 102 MEDR 2-19-39-3 Production Site 52.36506916, -114.417315