The University of Texas at Austin
McKetta Department
of Chemical Engineering
Cockrell School of Engineering

June 21, 2022

HEI Energy Virtual Open House:

Predictive, source-oriented modeling and measurements to evaluate community exposures to air pollutants and noise from unconventional oil and gas development

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Lea Hildebrandt Ruiz, Associate Professor (lhr@che.utexas.edu)

HEI energy

UT Austin Team: Principal Investigators

Lea Hildebrandt Ruiz
UT Austin

Measurements
Stakeholder Engagement
Project oversight

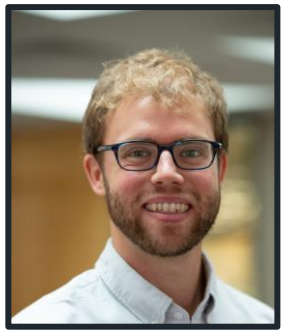
Pawel Misztal
UT Austin

Measurements

David Allen
UT Austin

Modeling
Stakeholder engagement

Lucas Henneman
George Mason U.



Exposure modeling

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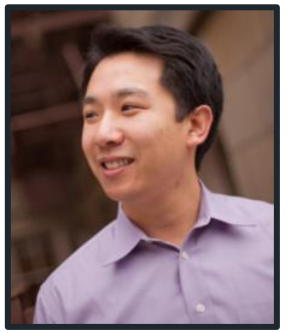
Public Health

Roger Peng
John Hopkins U.



Biostatistics

David Sullivan
UT Austin
Quality Assurance Officer

RoseAnna Goewey
UT Austin
Program Manager

UT Austin Project

Main goal : to generate a broadly applicable community model which can assess exposures to air pollutants from UOGD and inform future health studies

→ TRACER (TRAcking Community Exposures and Releases) model

Model combines fine-scale spatial-temporal **emission models**, molecular fingerprints of emission sources, and **dispersion modeling**.

Builds upon modeling capabilities developed at UT Austin to estimate emissions of methane: MEET; extended to light alkanes

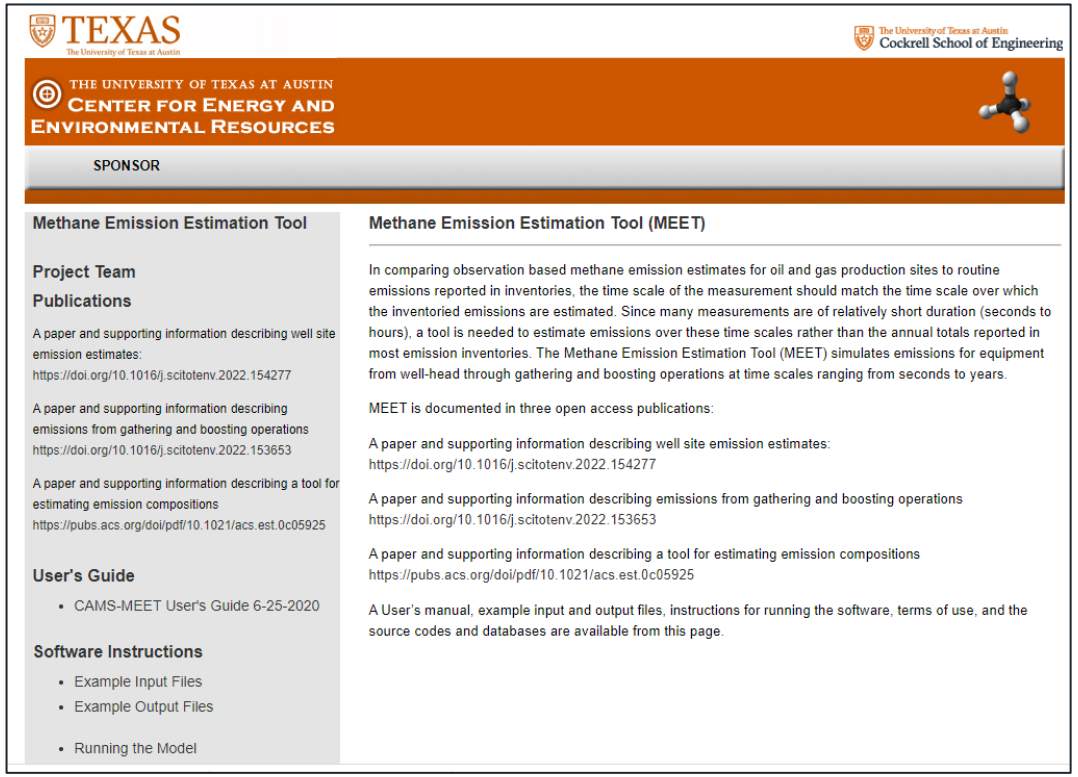
Targeted field measurements, in part to evaluate / refine the model.

Exposure modeling to evaluate exposure, inform future health studies

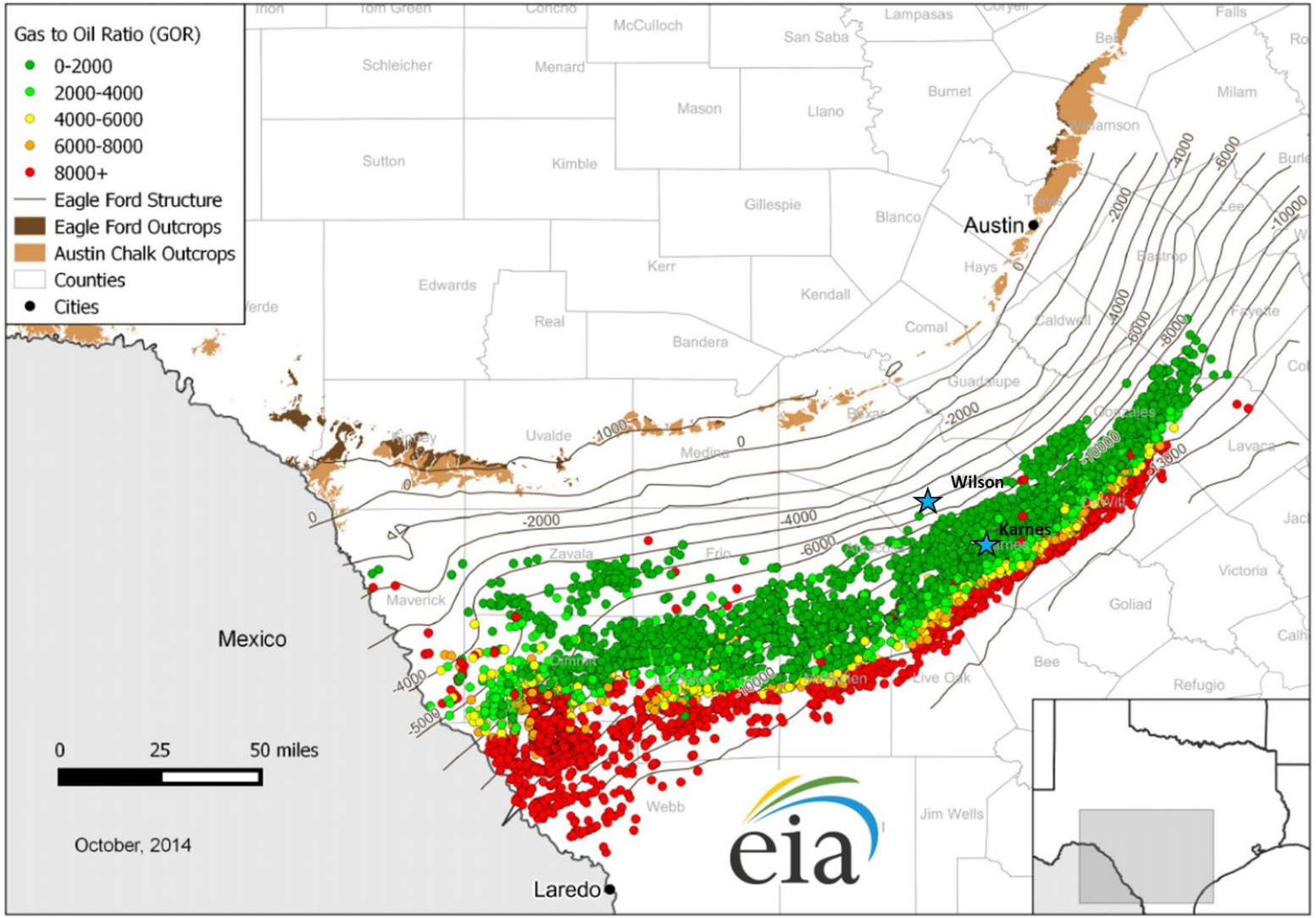
MEET Model for light alkane emissions from UOGD, which will be expanded in this work, now publicly available

http://dept.ceer.utexas.edu/ceer/meet/

- Model is described in three publications, all now published (open access) :
  - Emission composition tool paper published in ES&T https://pubs.acs.org/doi/pdf/10.1021/acs.est.0c05925
  - Paper describing model as applied to well sites published in Science of the Total Environment https://doi.org/10.1016/j.scitotenv.2022.154277
  - Paper describing compression and boosting sites published in Science of the Total Environment https://doi.org/10.1016/j.scitotenv.2022.153653
- Web site with source code, users manual, example input and output files and other information
  - On-line model tutorial also to be posted



Focus on the Eagle Ford Shale



Eagle Ford Shale (EFS) includes oil, wet gas, and dry gas wells. Its wide range in Gas to Oil Ratios (GORs) makes sub-regions within the EFS representative of a broad range of natural gas production regions throughout the US

U.S. Energy Information Administration, 2014

Model expansion – additional pollutants

Will add emission predictions of:

- alkanes and alkenes (up to C10)
- benzene, toluene, ethylbenzene and xylenes (BTEX)
- styrene
- aldehydes (formaldehyde, acetaldehyde and benzaldehyde)
- polycyclic aromatic hydrocarbons (PAHs, naphthalene and methyl naphthalene)
- H_2S, SO_2
- particulate matter, esp. black carbon

Model expansion – additional processes

Will add emissions from the following processes:

- Site preparation (drilling, hydraulic fracturing, truck traffic servicing sites). Data mostly from available activity data and emission factors, and data collected by HEI Energy research team led by Dr. Jeffrey Collett
- Emissions from unconfined flares (data from satellites)
- Unintended emissions (model stochastically, using incident reports)

Ambient Measurements - Site Selection

2 general regions in EFS (one of them in/near Karnes City), ~3 sites in each of the two regions; measurements during ~2 time periods → 12 measurement periods

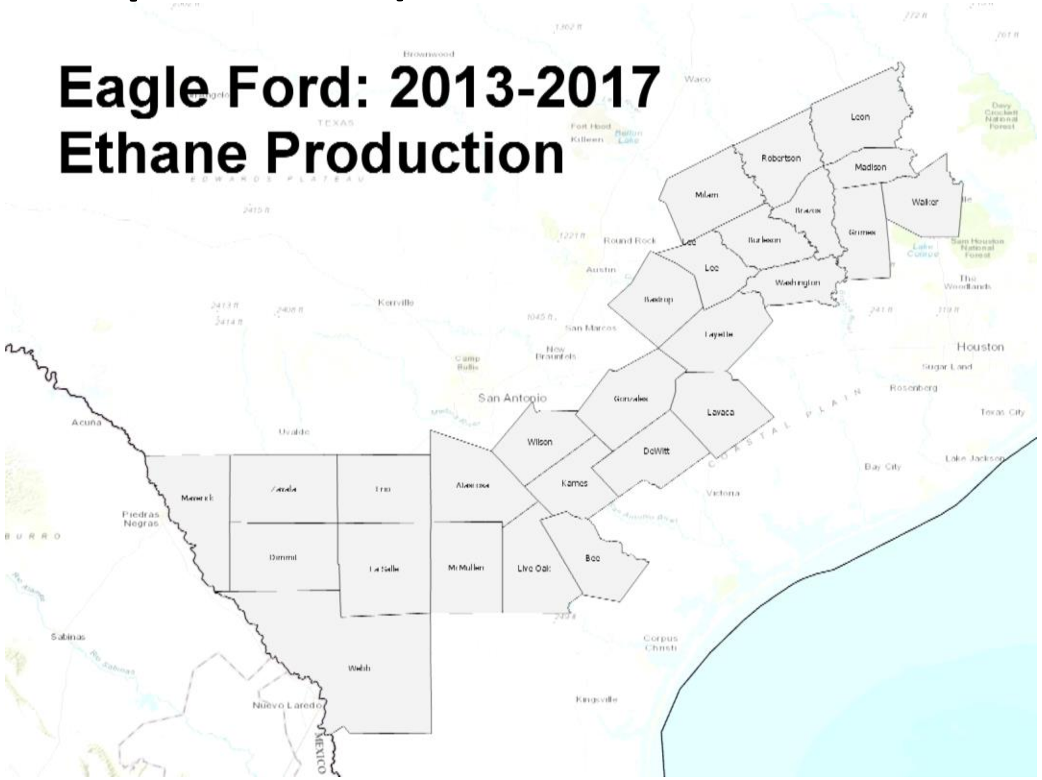
Locate stationary measurement sites near sources from which we expect different emissions (pollutant concentrations and concentration ratios), for example, locate near:

- Tank batteries
- Gathering and boosting
- Gas-processing plants
- New drilling activity
- Regional background / downwind site

Considerations for Siting and Timing of Measurements

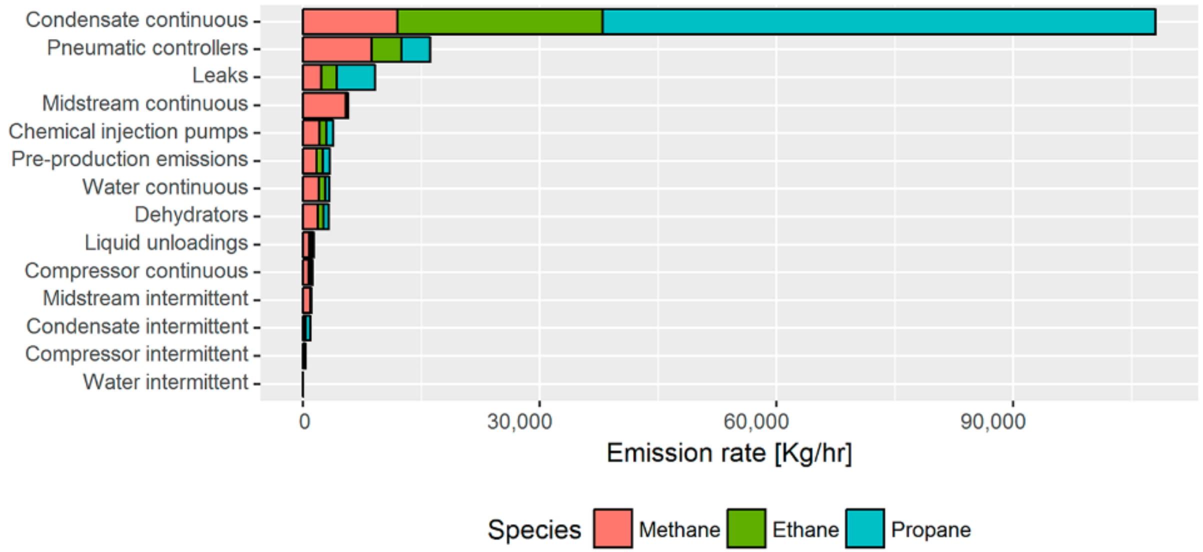
Emission modeling in the Eagle Ford Shale

Temporal variability in production by month over a 5 year period (using ethane as a surrogate for total production)



Light alkane emissions estimated, by site, for ~20,000 sites; performance evaluation of inventory performed by comparison with ground monitors

Environ. Sci. Technol. 2019, 53, 5483–5492



Emissions dominated by intermittent tank flash; new EPA regulations proposed that would alter the top two emission sources for light alkanes – **schedule sampling before and after implementation of mitigation measures?**

Ambient Measurements – Platforms and Instrumentation

Mobile Measurements: Vocus PTR-ToF (hydrocarbons), Picarro (CH_4/C_2HO), Thermo Scientific 450iQ(H_2S/SO_2), Aethalomter (BC)

Stationary Measurements: GC (hydrocarbons), Iodide-CIMS (inorganics including Cl_2, $ClNO_2$, N_2O_5; oxidized hydrocarbons), Aerosol Chemical Speciation Monitor (ACSM, PM mass and bulk composition), SEMS (particle size distributions), NO_x, O_3, NO_2, Noise (Bruel & Kjaer 2250)

Mobile measurements synchronized with ambient measurements.

General Timeline of UT Austin Project

Year 1 (2022): Model expansion, initial modeling, preparation for measurements, measurement site selection

Year 2 (2023): Ambient measurements in Eagle Ford Shale and analysis, model/measurement comparisons, model refinement, sensitivity analyses (e.g. impact of meteorology)

Year 3 (2024): Finish measurements and analysis, finalize modeling, conduct exposure assessment

We will also assist with emissions modeling in the Denver Julesburg Basin.

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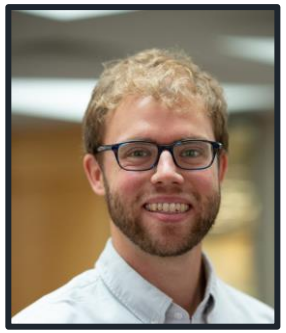

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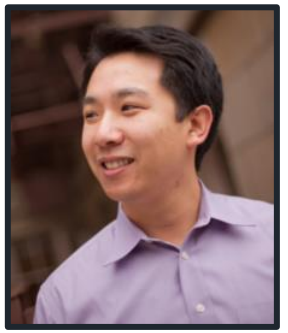

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