NO_x

CH_4 CO NH_3 N_2O

Sources and solutions:

Linking atmospheric measurements of greenhouse gas and air quality emissions from agriculture at regional scales

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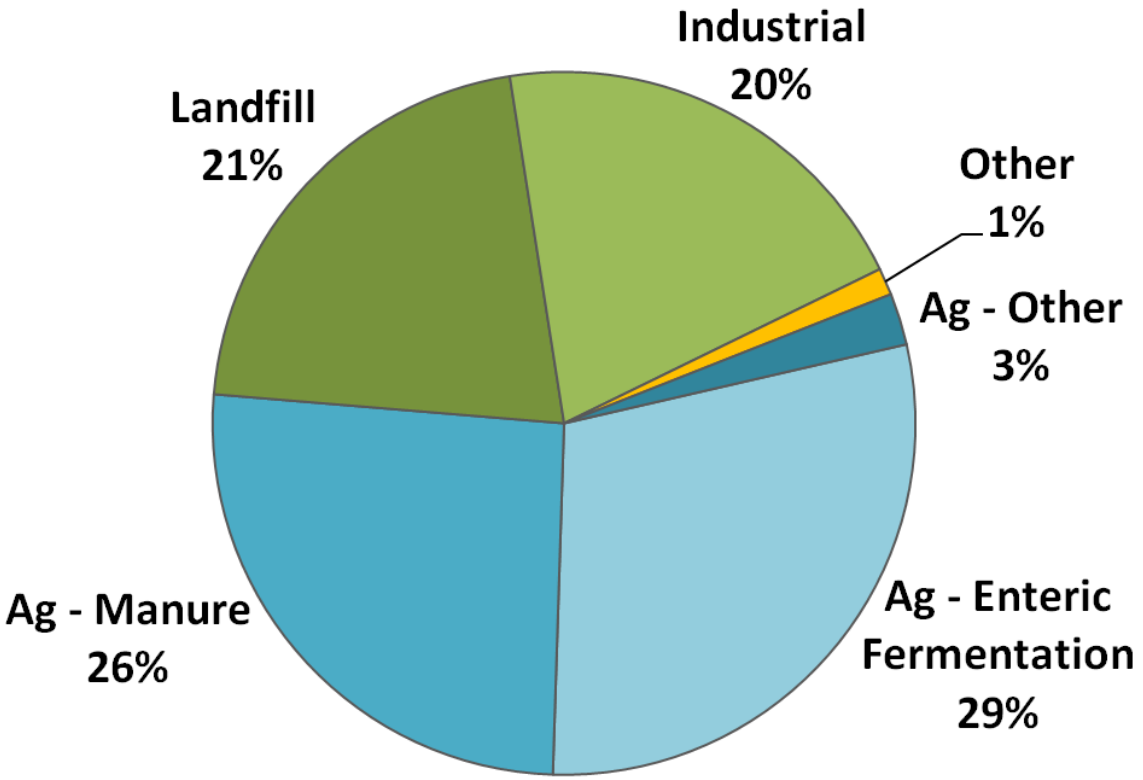
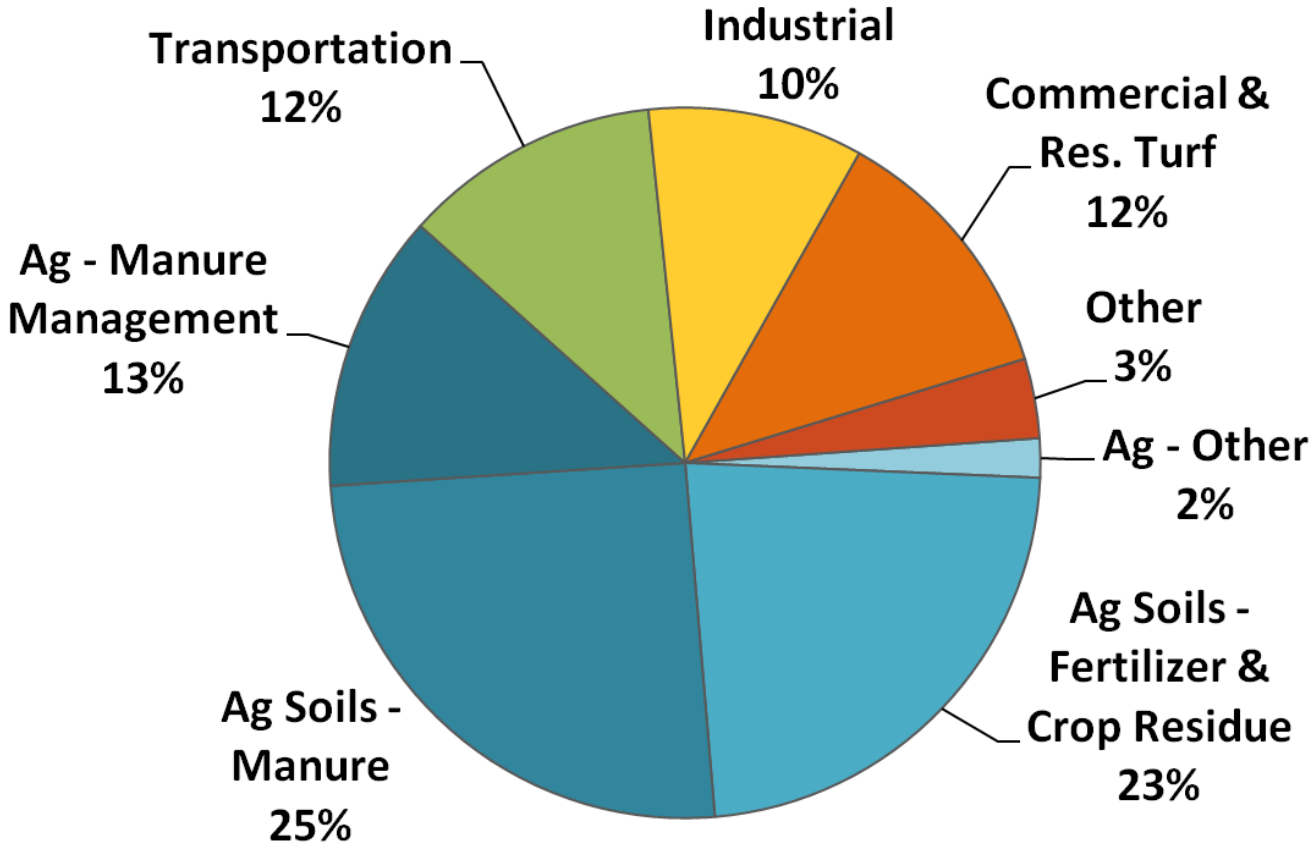
CH_4 & N_2O: ~14% of CO_2e in California



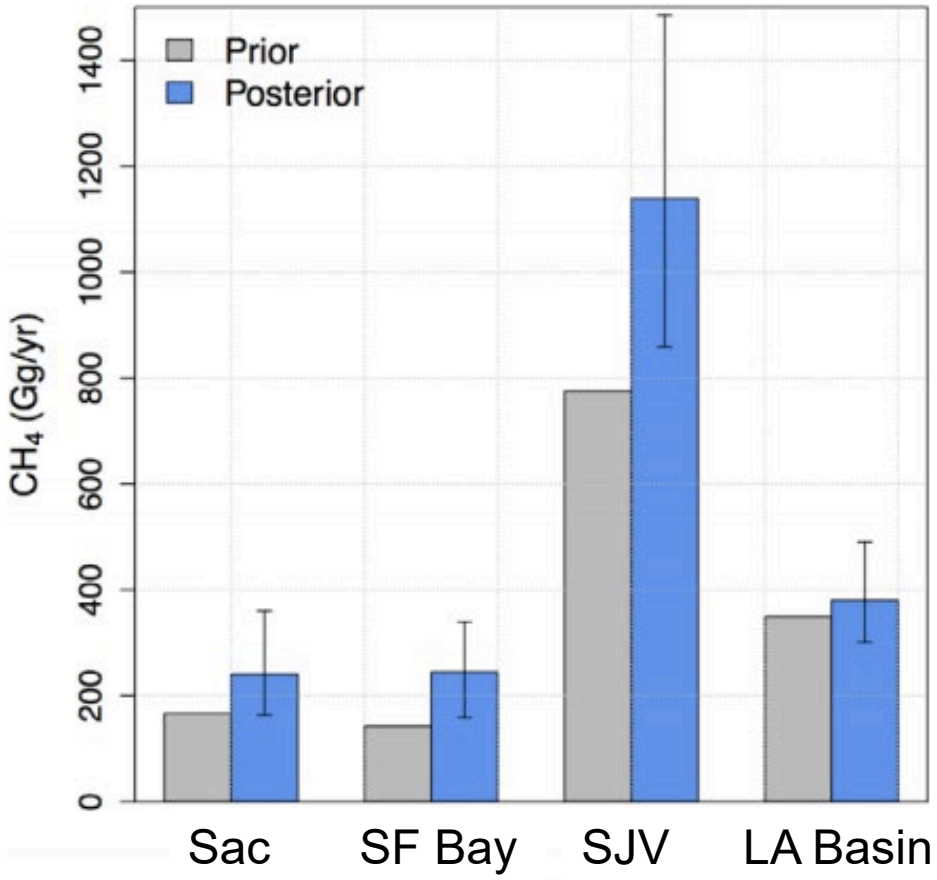


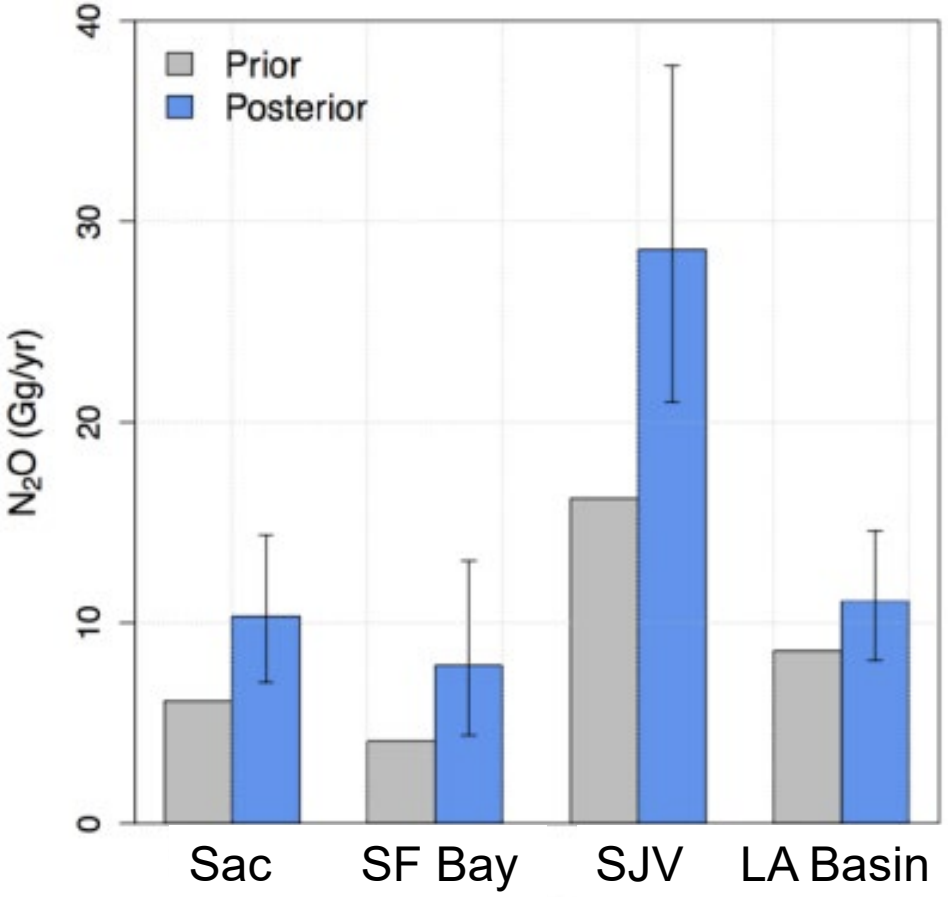
2015 Total CH4 Emissions: 39.6 MMTCO2e

2015 Total N2O Emissions: 11.7 MMTCO2e

California Air Resources Board Greenhouse Gas Inventory

Atmospheric observations suggest that CH_4 and N_2O are underestimated by inventory



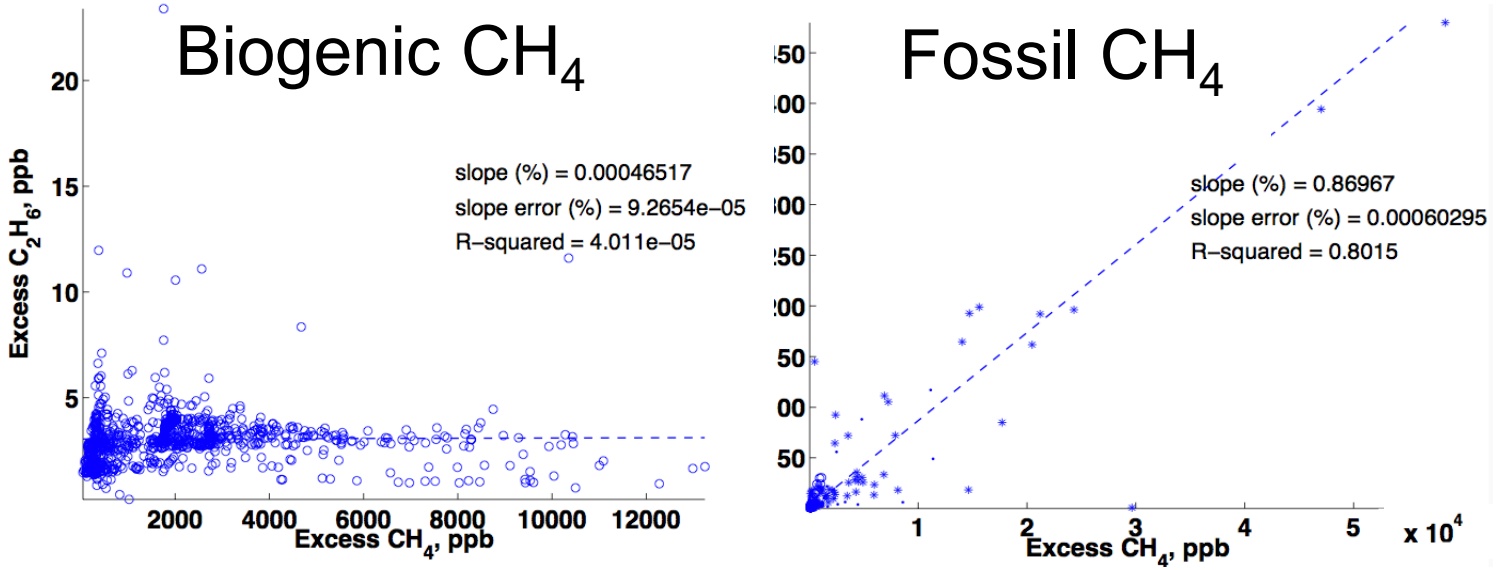


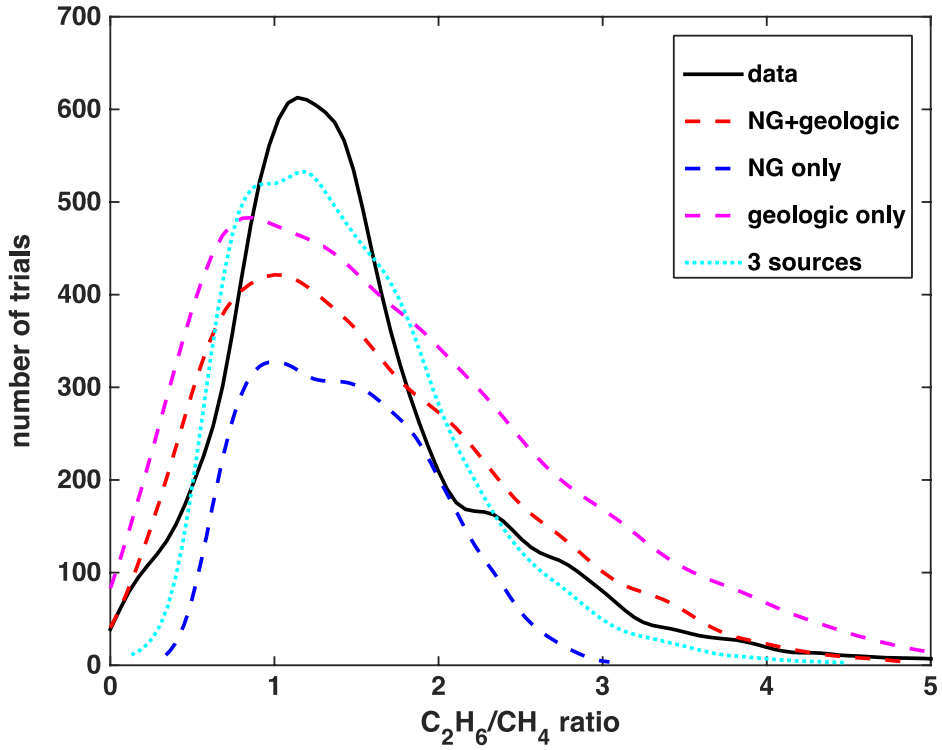
***difference greatest in winter

Jeong et al., 2016

Atmospheric observations also differ on relative contributions of different emission sources (CH_4)

C_2H_6/CH_4 measurements for known CH_4 sources





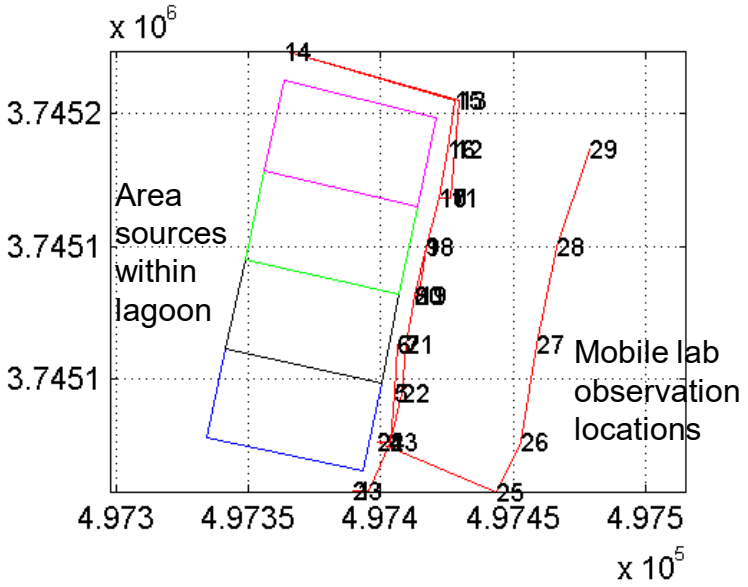
Regional scale source apportionment:
fossil CH_4 source underestimated in LA Basin

Hopkins et al., 2016

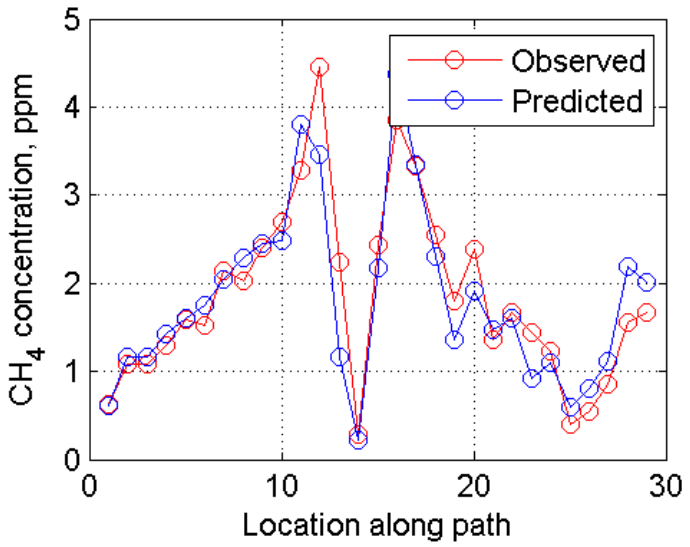
Observations of CH_4 emissions show high spatial (and temporal) variability

…and can this variability be linked to processes?

Estimation of manure lagoon emissions with mobile lab observations and numerical dispersion model: 5 fold drop in emissions across 100 m



Carranza, Venkatram, Hopkins unpublished



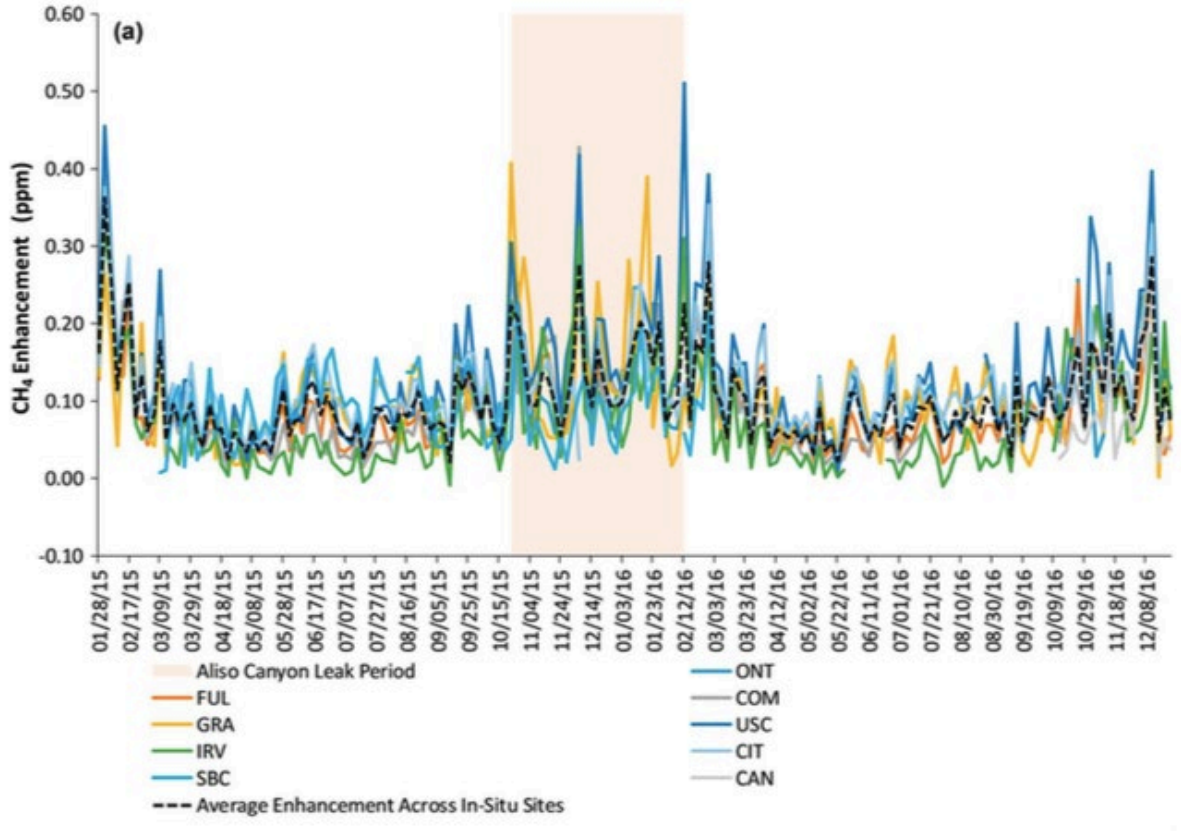
Observations of CH_4 emissions show high spatial (and temporal) variability

…and can this variability be linked to processes?

Difficult to do at the regional scale given covarying seasonal changes in meteorology and biophysical drivers

Lower mixing layer depth and wind speeds in winter: higher enhancements

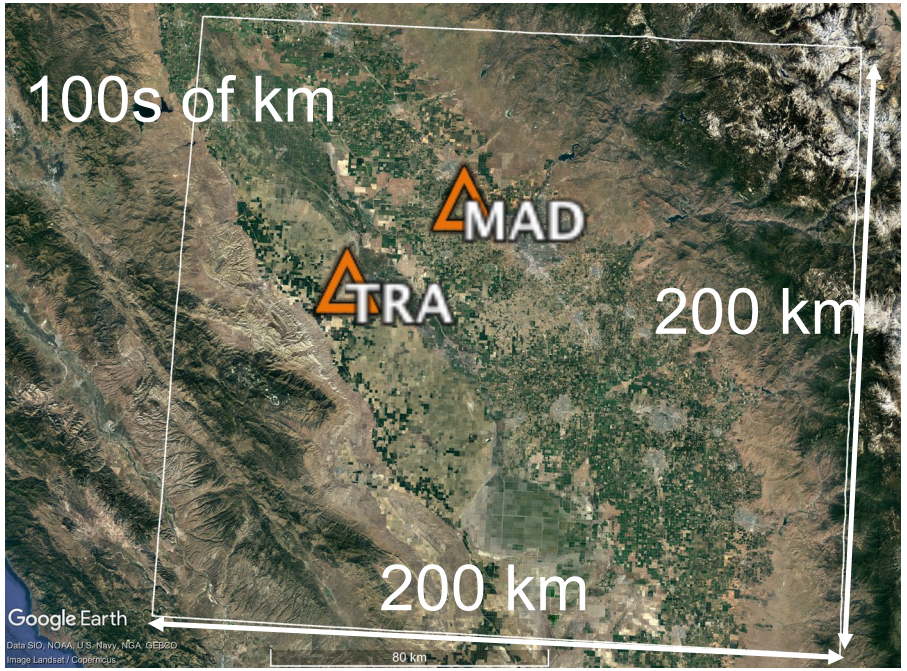
Yadav et al., 2019

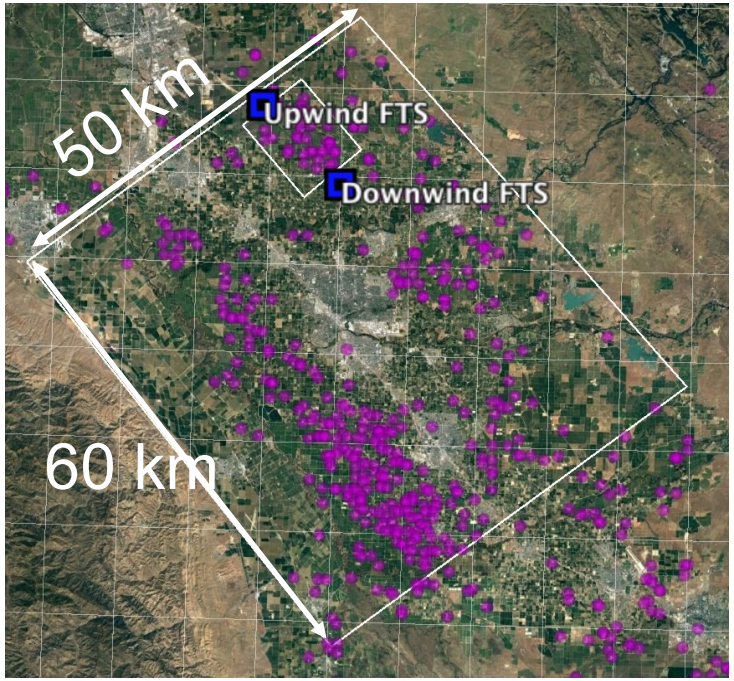


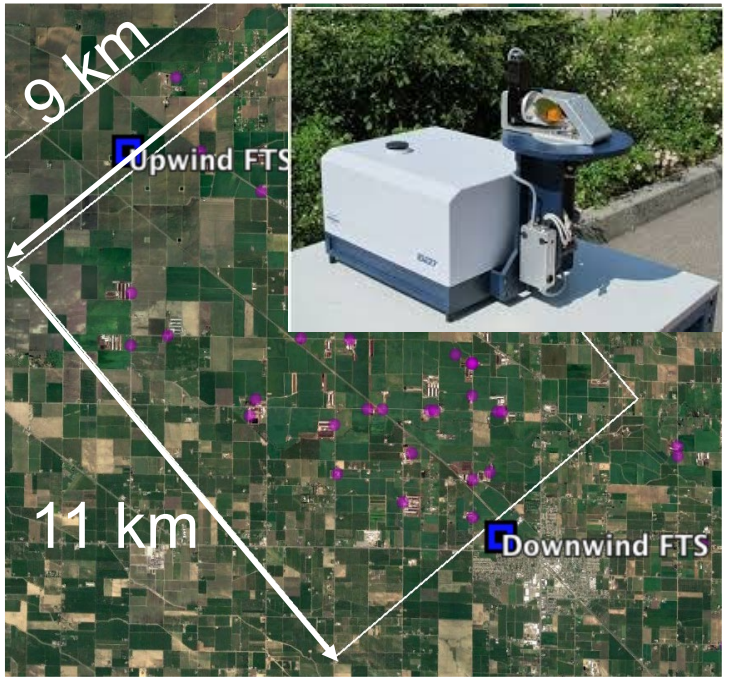
Can we measure the effect of GHG mitigation in the atmosphere?

California state law: reduce CH_4 40% by 2030

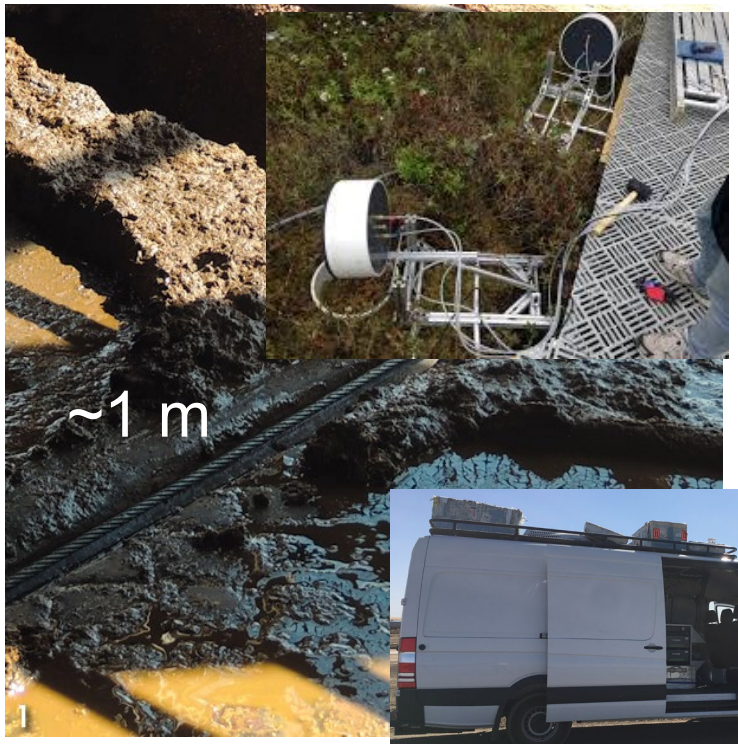
- $114.25 million awarded as of Jan. 2019 to construct anaerobic digesters to capture dairy manure CH_4
- 57 anaerobic digesters currently under construction with more to be funded in late 2019
- Large enough signal to verify?

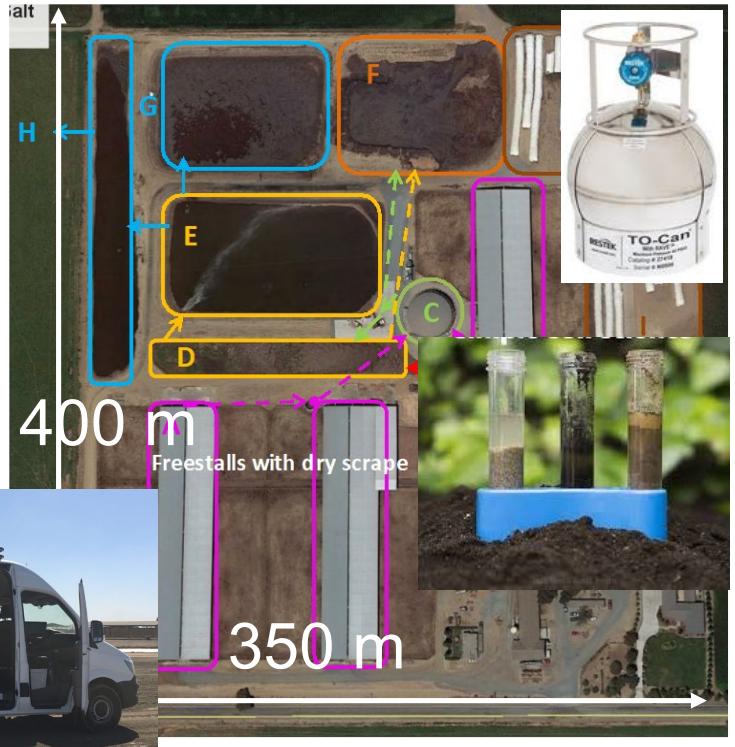






U of Calif. study: Observations across scales to address uncertainties in dairy manure methane emissions





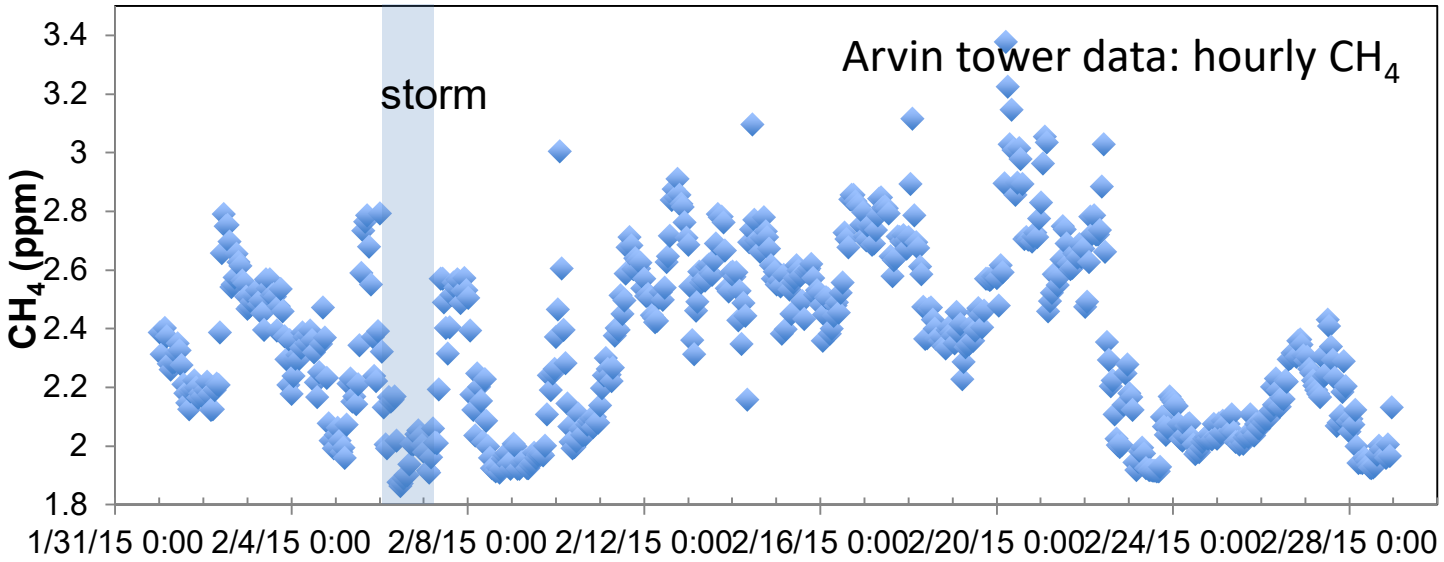
Laboratory for Isotope Measurements in the Environment /Analysis Vehicle for On-road Capture of Atmospheric Data and Observations

Mobile measurements of CH_4, CO_2, N_2O, NH_3, stable isotopes of CH_4, CO_2 and N_2O

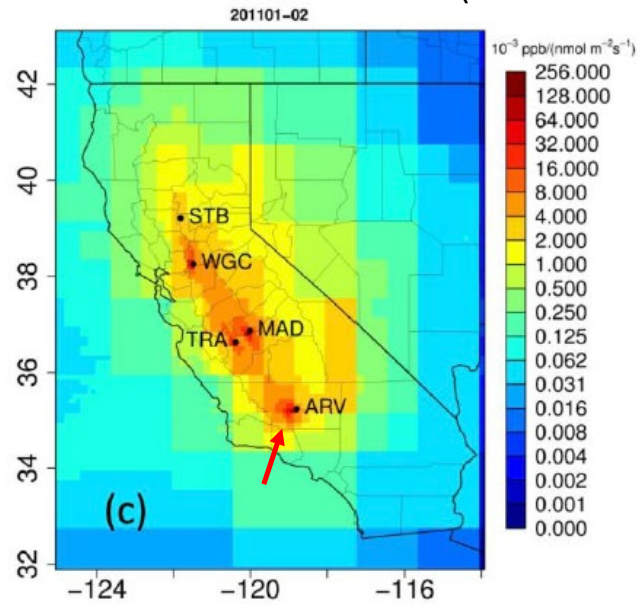
UCR LIME/AVOCADO

How can studies of greenhouse gases help assessments of air quality?

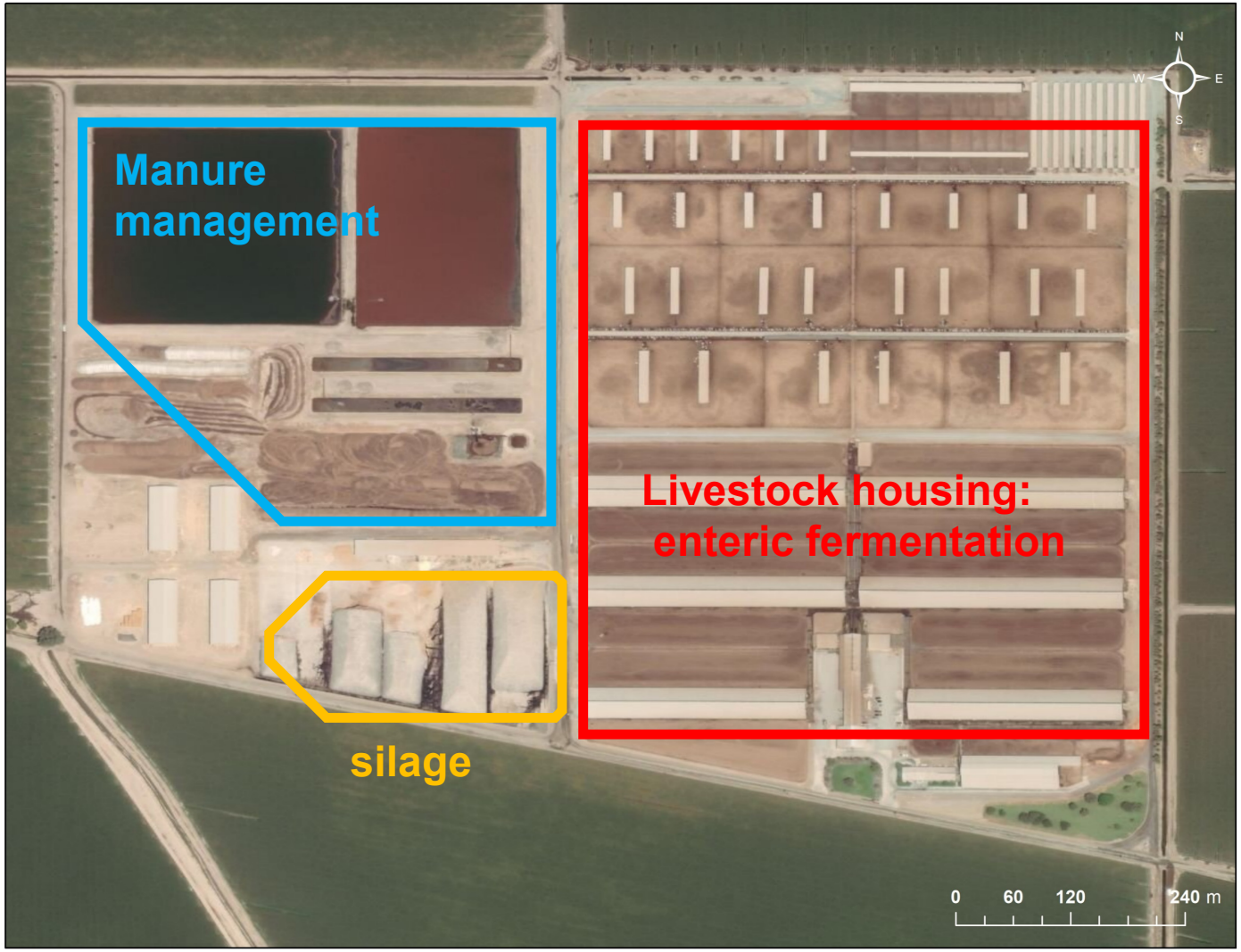
- Same measurement tools for GHGs and criteria pollutants
- Same sources for some GHGs and criteria pollutants
- Similar meteorological challenges and tools
- Contrasting lifetimes: long lived GHGs can be a tracer

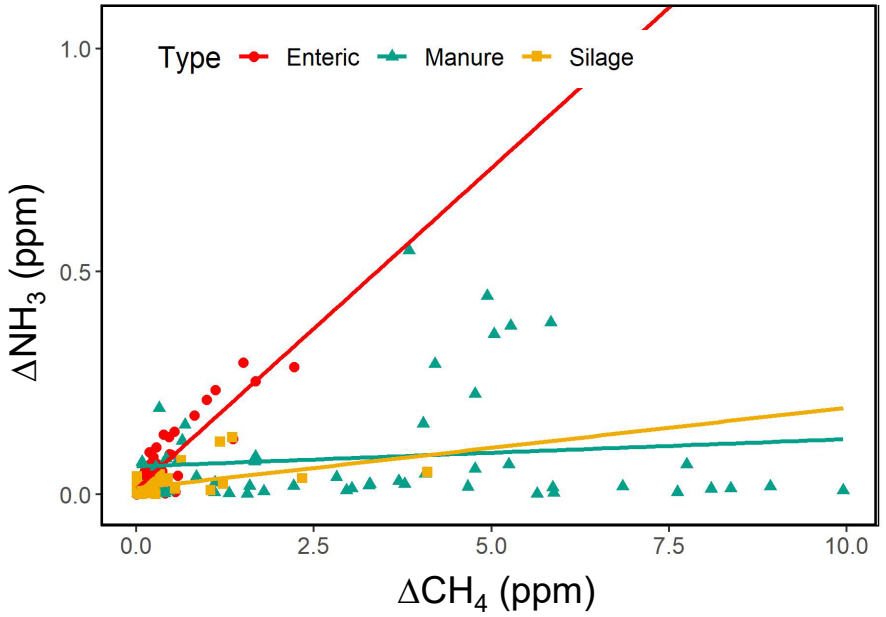


Seasonal mean footprint, noon-afternoon for Jan.-Feb. 2011 (Fischer et al. 2012)



Recommendation: Use co-measurement of GHGs and criteria pollutants to determine a “fingerprint” for different source types

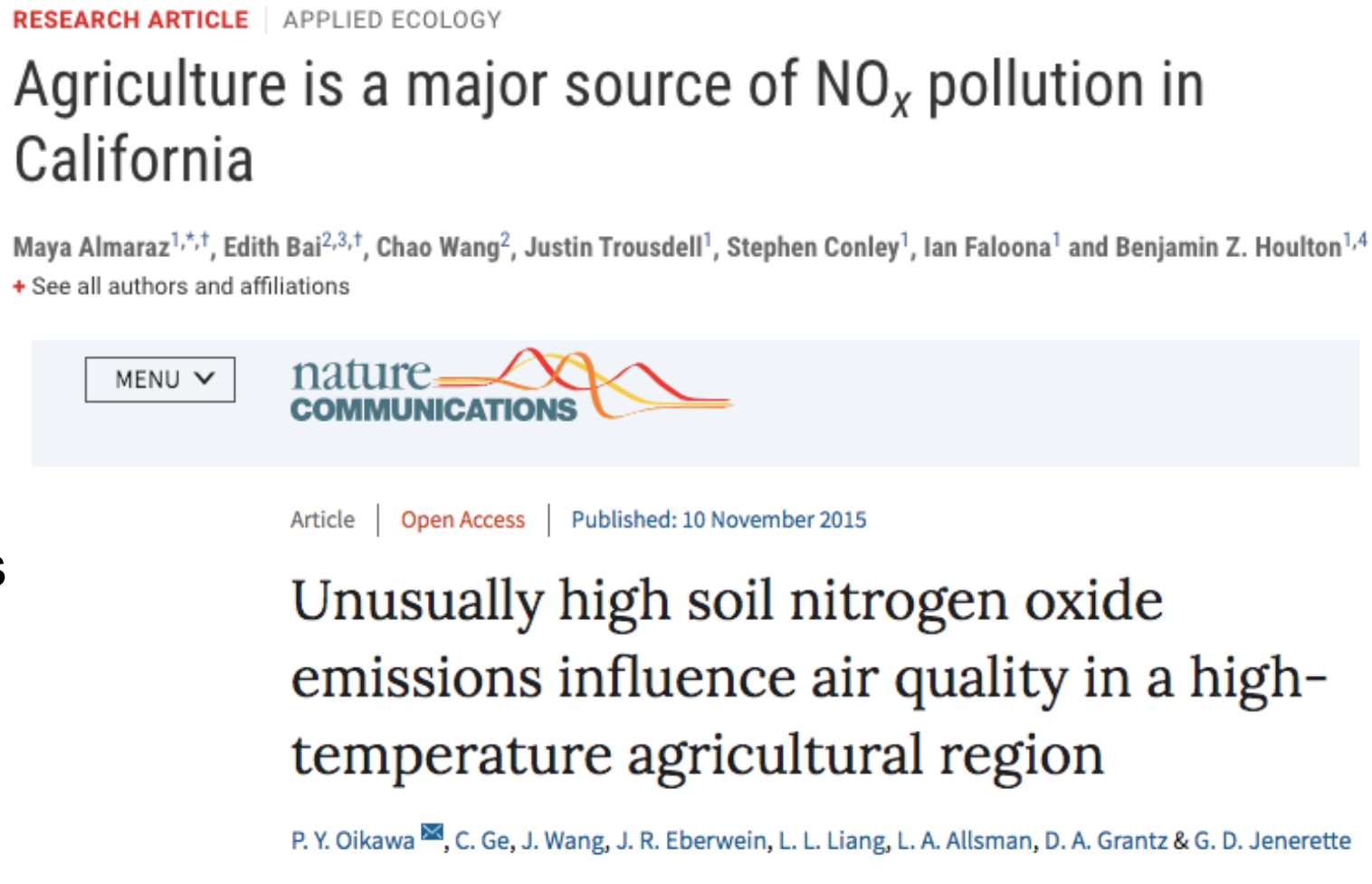




- Some pollutants have the same sources as GHGs (NH_3 & CH_4)
- Also N trace gas emissions from soils: NO_x & N_2O

Recommendation: Include soils and biogeochemical processes

- Improved inventories that link GHGs and criteria pollutants
- Soil studies: new insights N trace gas emissions from soils, esp. NO_x & N_2O (thanks Ian Faloona!)
- Process modeling that includes agricultural practices can improve parameterization of NH_3 and CH_4



RESEARCH ARTICLE | APPLIED ECOLOGY

Agriculture is a major source of NO_x pollution in California

Maya Almaraz[1,*,†], Edith Bai[2,3,†], Chao Wang[2], Justin Trousdell[1], Stephen Conley[1], Ian Faloona[1] and Benjamin Z. Houlton[1,4]

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Unusually high soil nitrogen oxide emissions influence air quality in a high-temperature agricultural region

P. Y. Oikawa, C. Ge, J. Wang, J. R. Eberwein, L. L. Liang, L. A. Allsman, D. A. Grantz & G. D. Jenerette

Recommendation: Better quantify atmospheric transport uncertainty on emission estimates

- Atmospheric transport uncertainty important in both cases

Wintertime Western US basin challenges:

- Low windspeeds
- Pooling of polluted air
- Efforts to improve atmospheric transport uncertainties will yield benefits for better understanding sources of both types of trace gas pollutants

Recommendations: Study impact of mitigation activities

- Large scale transformation of dairy manure management practices to take place in California intended to reduce CH_4
- Impact on NH_3?
- Impact on N_2O? Fertilizer use? Other N losses (or retention) from soil after land application?
- Before and after studies needed

Recommendations for future wintertime air quality study

- Take advantage of ability to measure GHGs and reactive species together
- Link biogeochemical processes to observations through experiments, measurements, inventories, models
- Join forces to beat down and better quantify transport uncertainties
- Examine co-benefits (and possible negative consequences) of mitigation of GHGs on air quality (and vice versa)