

Greenhouse Gas Emission from Manure Management at California Dairies: Linking Observations Across Scales for Improved Understanding of Emissions

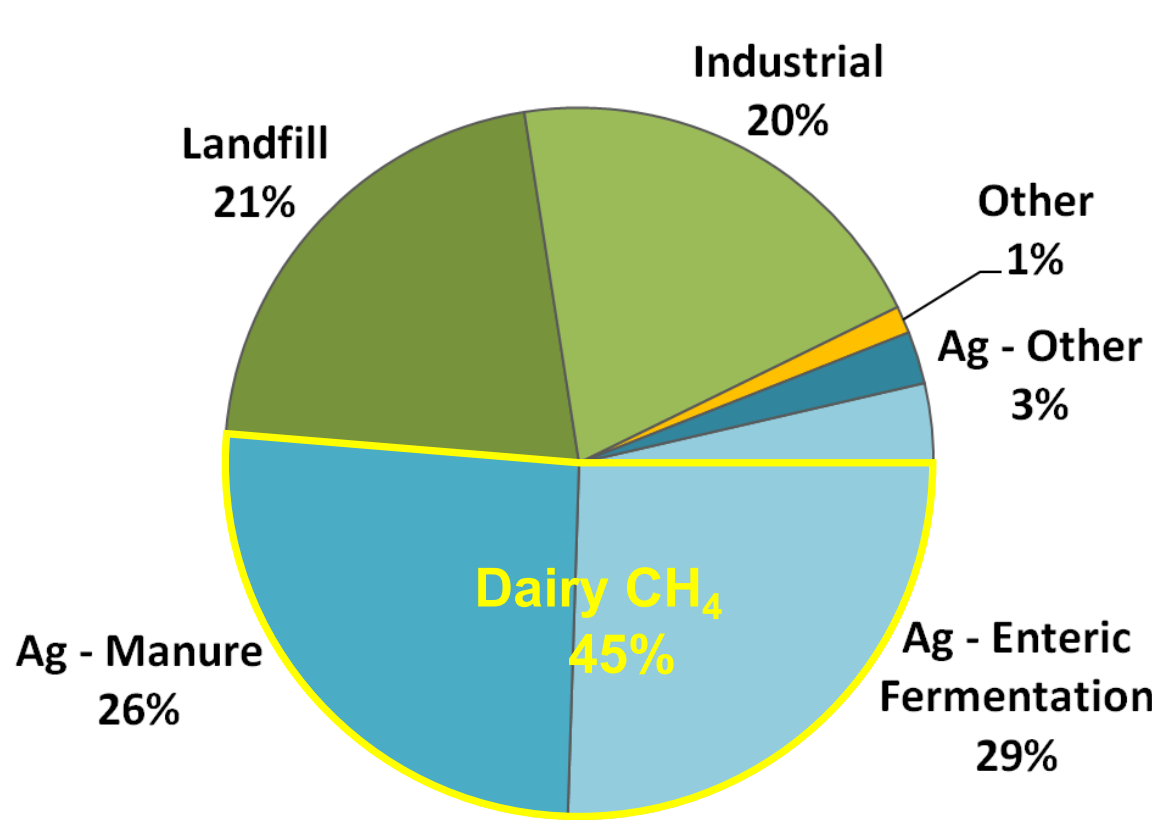
**Dairy and Livestock Working Group Joint Subgroups Meeting
July 27, 2018
Fresno**

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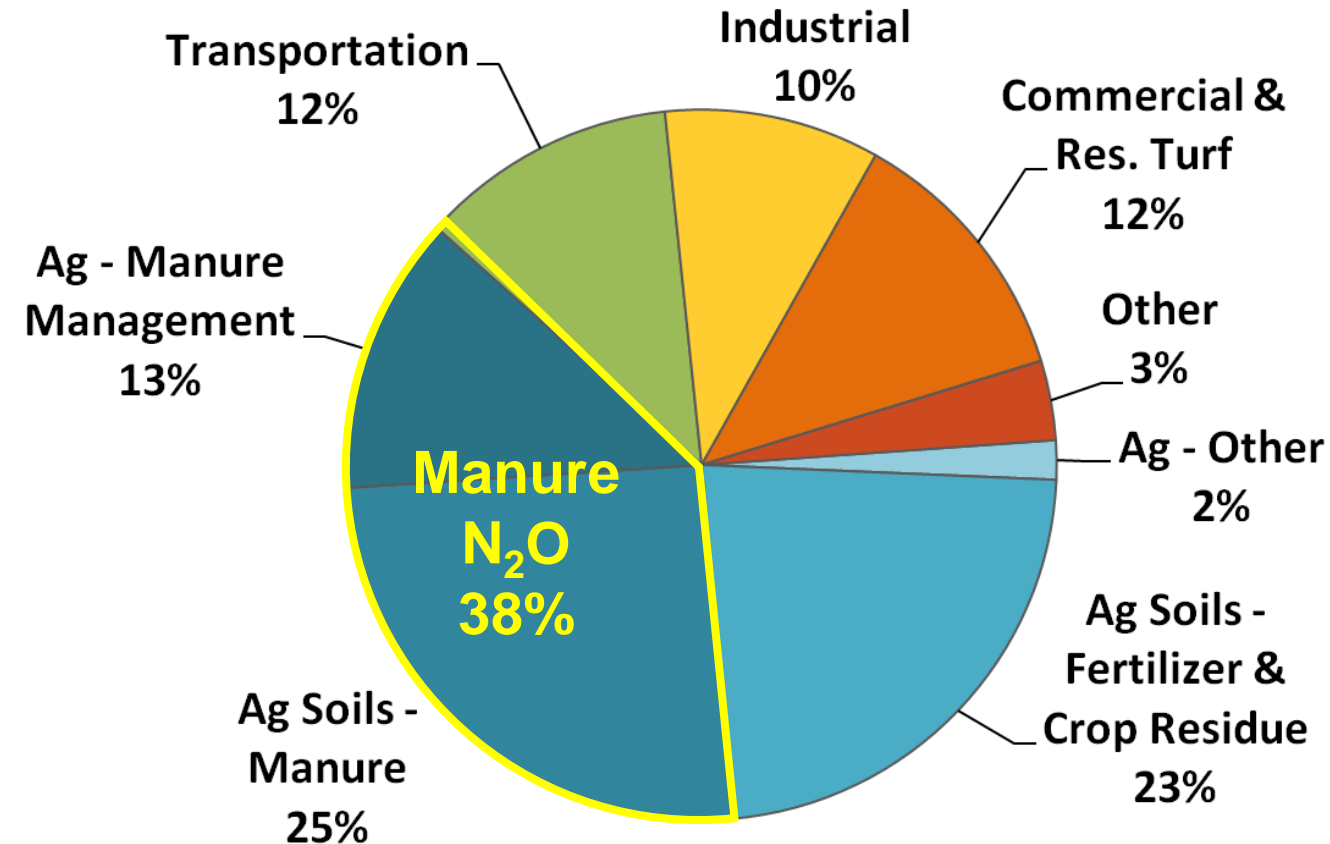
[Francesca M. Hopkins,](#)

Marc Fischer, Seongeun Jeong,
Manvendra Dubey,
Whendee Silver, Deanne Meyer, Akula
Venkatram, Don Blake

Greenhouse Gas Emissions from Dairy

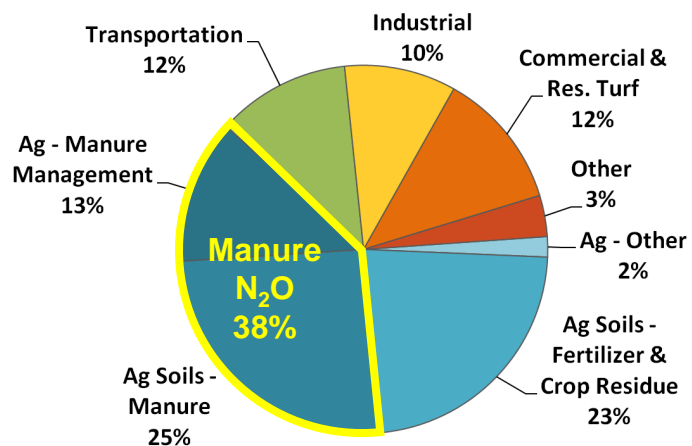
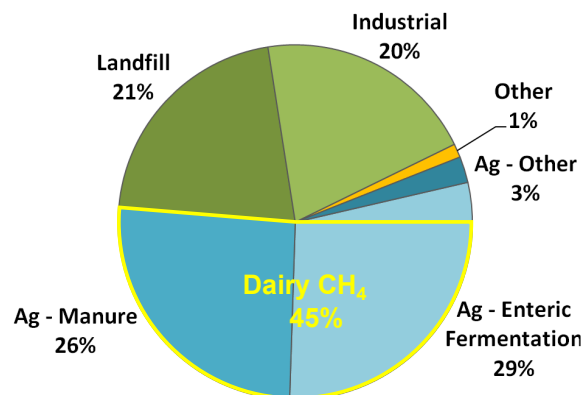


2015 Total CH₄ Emissions: 39.6 MMTCO₂e

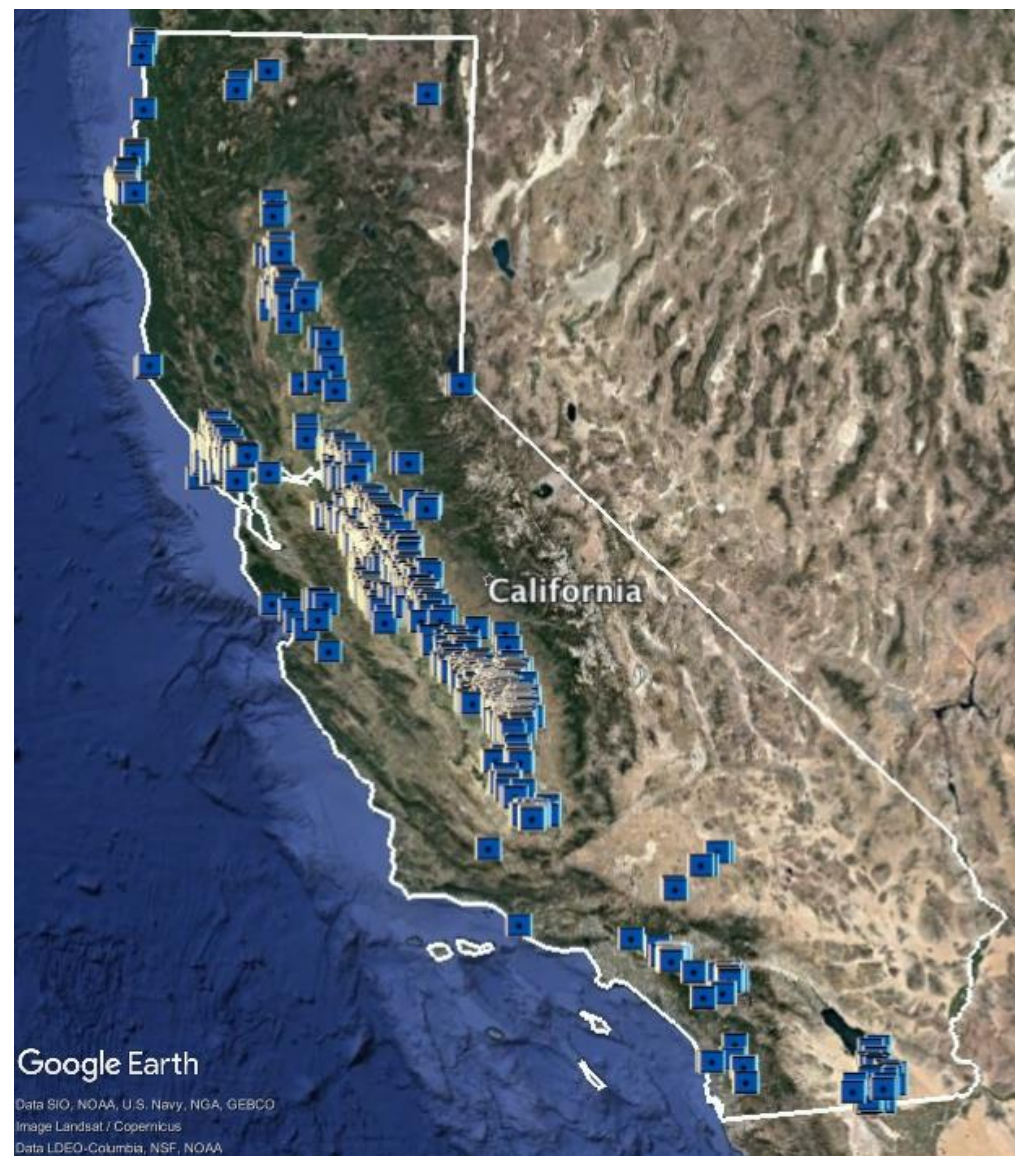


2015 Total N₂O Emissions: 11.7 MMTCO₂e

We Need Better Tools for Evaluating Changes in Emissions

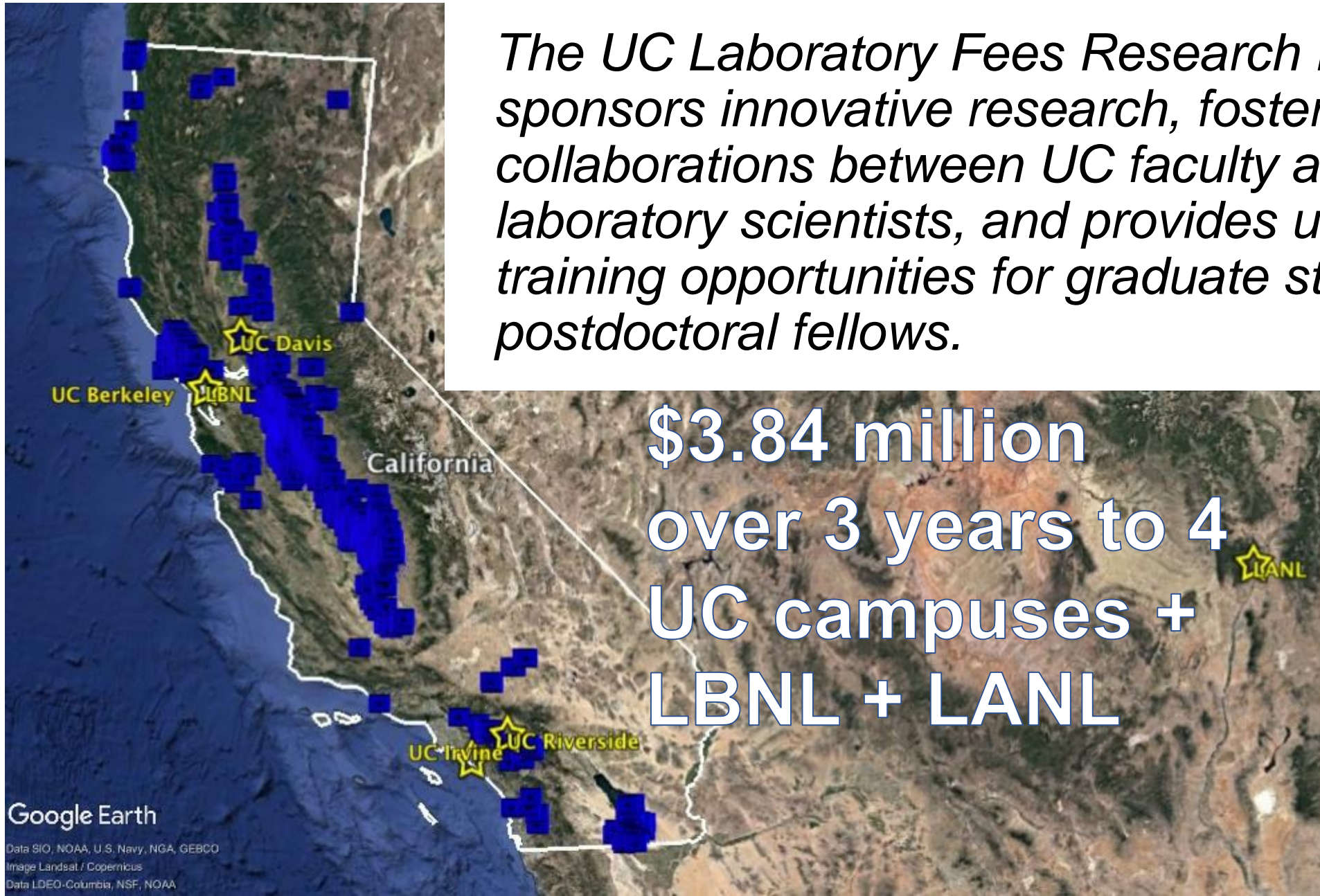


California Air Resources Board
Greenhouse Gas Inventory



Univ. of California Laboratory Fees Research Program:

The UC Laboratory Fees Research Program sponsors innovative research, fosters new collaborations between UC faculty and national laboratory scientists, and provides unique training opportunities for graduate students and postdoctoral fellows.



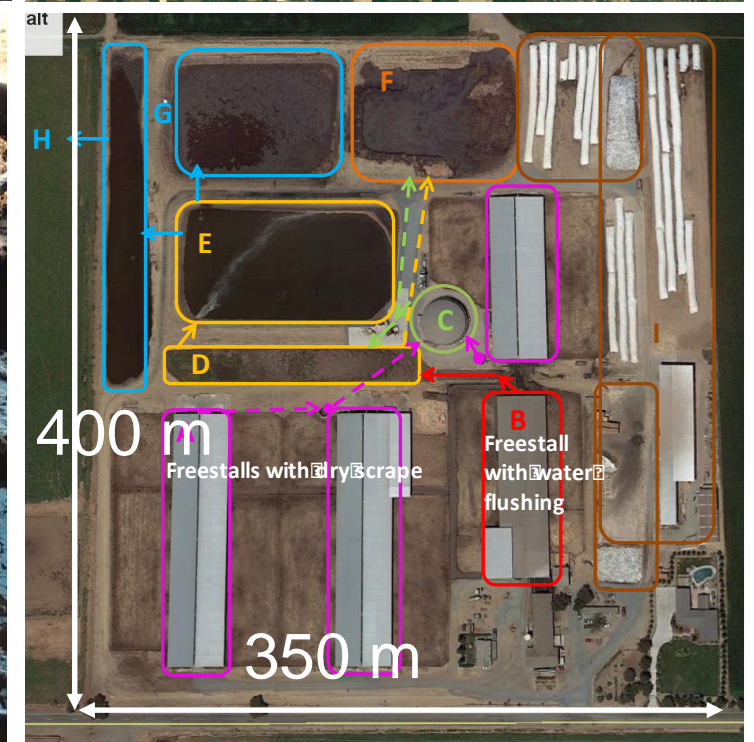
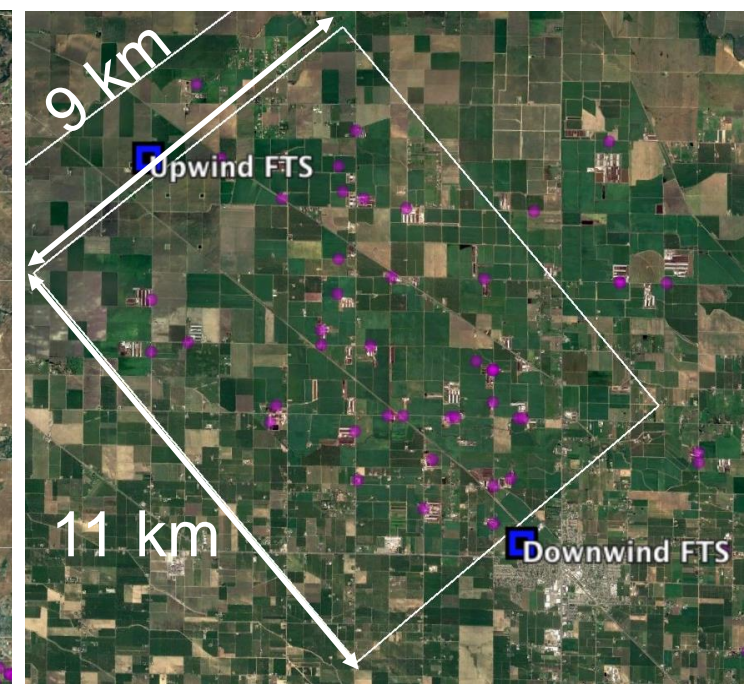
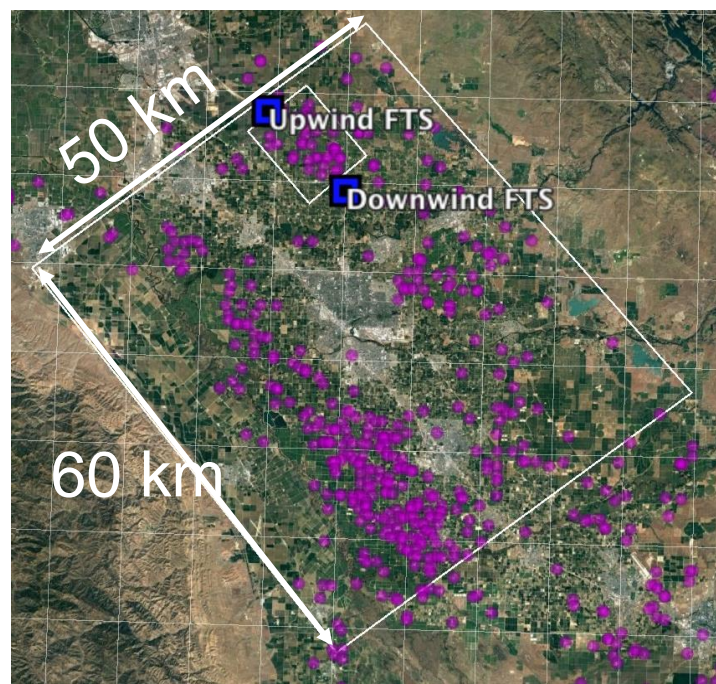
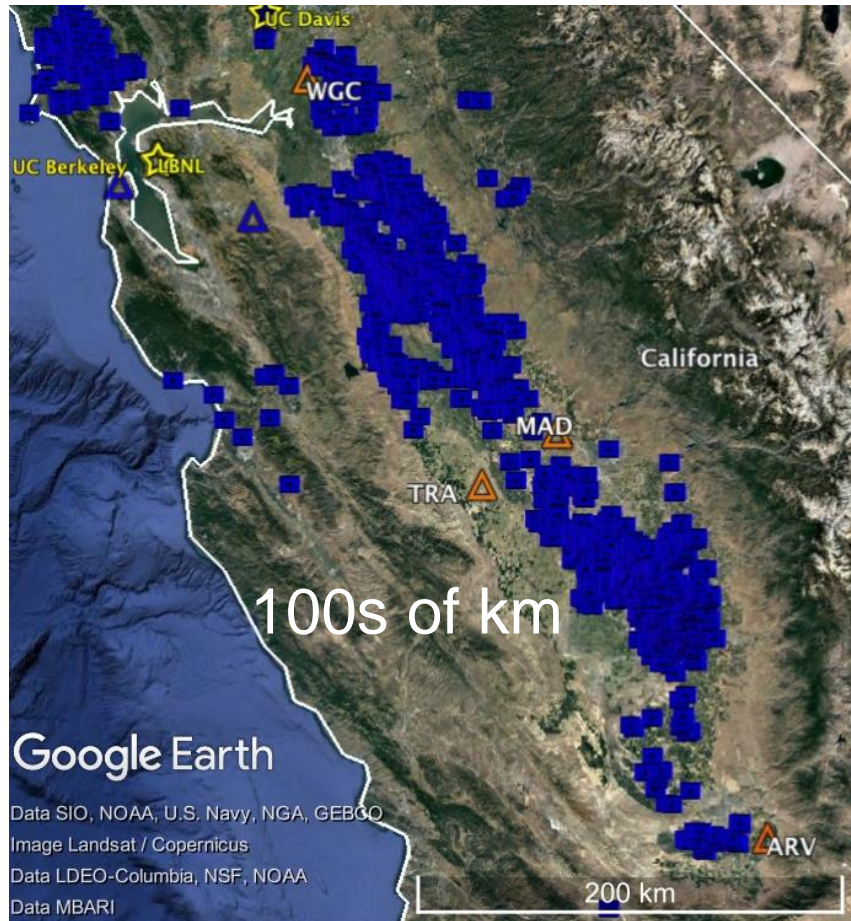
Science Questions

- *Why do current inventories underestimate dairy greenhouse gas emissions?*
- *What are the best methods and observational scales to assess greenhouse gas emissions from dairy farms?*
- *How can methane and greenhouse gas emission reduction strategies for manure management be most effectively deployed and verified?*

Multi-tiered observing strategy with observations at various scales

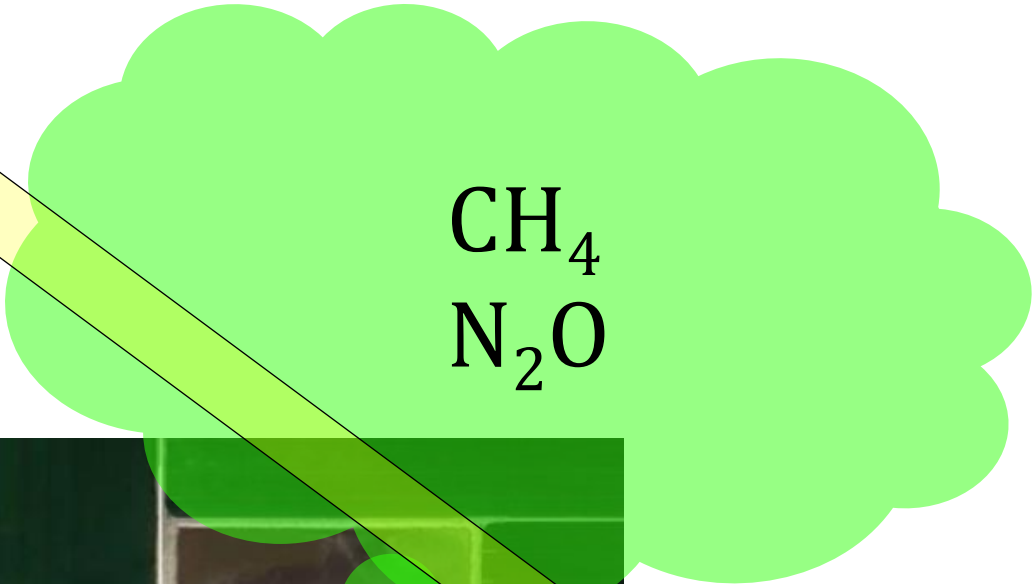
- Continuous regional tower measurements with WRF-STILT inversions
- Campaign deployments at 10s of km with upwind/downwind solar Fourier Transform Spectrometry (FTS) measurements
- Farm-scale surveys with mobile sampling of greenhouse gases and dispersion modeling
- Infrastructure-level surveys and continuous observations of emissions, including manure lagoons, piles, and fields with applied manure
- Measurement of drivers of CH₄ and N₂O emissions from manure handling at dairies, including documentation and characterization of volatile solid flows, and drivers of spatial and temporal variability

Observations across scales



Techniques

Remote sensing



CH_4
 N_2O

EM27/Sun



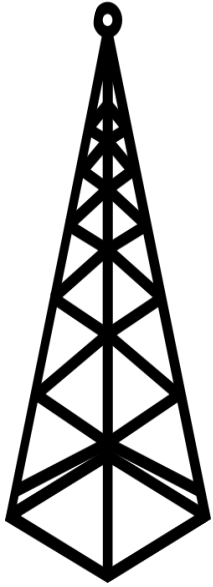
EM27/Sun



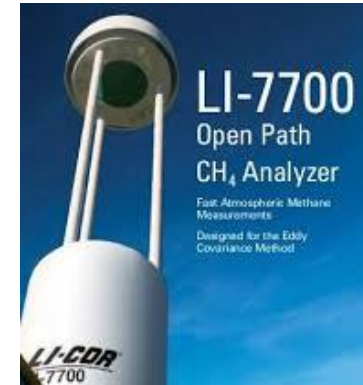
Techniques

In situ

Towers



Micrometeorological measurements of manure lagoons and piles



Autochamber measurements on fields with manure application



Volatile solid characterization



Air sampling for VOCs and source apportionment



Mobile Surveys

Cavity ring down spectroscopy for atmospheric CH₄ mole fraction and methane isotopes



Improved process understanding to fill in knowledge gaps

- Source apportionment with methane stable isotopes and spatial patterns
- Linking greenhouse gas emissions CH_4 and N_2O with other air pollutants, including volatile organic compounds (VOCs) and ammonia (NH_3)

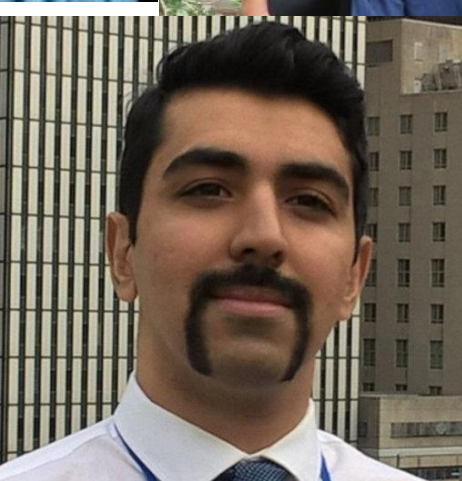
Linking bottom-up and top-down observations

- Development of high-resolution (farm-scale) bottom-up emissions inventory based on CALGEM and Vista-LA frameworks and publicly available data
- Process modeling with DAYCENT, Manure DNDC, Ecosys models to upscale field measurements

How can methane and greenhouse gas emission reduction strategies for manure management be most effectively deployed and verified?

- **Predict outcomes of proposed policy or management changes on GHGs**
 - Process modeling and improved process understanding to predict emissions
- **Design observational strategy to verify emissions reductions**

Team



Climate Impact of Manure Management from California Dairies

Francesca Hopkins

fhopkins@ucr.edu

(951) 827-4781