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

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Fresno

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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
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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 CH$_4$ and N$_2$O emissions from manure handling at dairies, including documentation and characterization of volatile solid flows, and drivers of spatial and temporal variability
Observations across scales

Freestalls with dry scrape

Freestall with water flushing

~1 m

400 m

350 m
Techniques

Remote sensing

Wind direction

EM27/Sun

CH$_4$

N$_2$O

EM27/Sun
Techniques

In situ

Towers

Micrometerological measurements of manure lagoons and piles

Autochamber measurements on fields with manure application

Mobile Surveys

Cavity ring down spectroscopy for atmospheric CH$_4$ mole fraction and methane isotopes

Air sampling for VOCs and methane source apportionment

Volatile solid characterization
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$_2$O 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

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