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$_2$O: ~14% of CO$_2$e 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$_2$O 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$_2$H$_6$/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Carranza, Venkatram, Hopkins unpublished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$_2$O, NH$_3$, stable isotopes of CH$_4$, CO$_2$ and N$_2$O

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 (NH₃ & CH₄)
- Also N trace gas emissions from soils: NOₓ & N₂O
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$_2$O (thanks Ian Faloona!)
- Process modeling that includes agricultural practices can improve parameterization of NH$_3$ and CH$_4$
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$_2$O? 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)