Agriculture that feeds the world affects climate, air quality and stratospheric ozone

Crop Fertilization

Fertilizer made from synthesized Ammonia

**Ammonia**: emitted from fertilized fields, leads to particle formation

Air quality and climate

**Nitrous oxide**: emitted from fertilized fields increase mostly from agricultural intensification

Climate and stratospheric ozone

Concentrated animal feeding operations

**Methane**: emitted from animal digestion and manure emissions from ruminants ≈ fossil fuels

Climate

**Ammonia**: emitted from animal waste

CSD’s response: develop techniques to quantify variable ammonia, nitrous oxide, methane emissions
Large uncertainties in agricultural emissions

Example: CSD’s Calnex 2010 study, NOAA WP-3 aircraft flights over agriculture

Area-wide agricultural emission fluxes quantified and compared to inventories:

**Ammonia**: Large fluxes from dairies
Underestimated by emission inventories
*(Nowak et al., GRL, 2012)*

**Nitrous oxide**: Large fluxes from agriculture
Underestimated by emission inventories
*(Xiang et al., JGR, 2013)*

**Methane**: Large fluxes from rice cultivation
Underestimated by emission inventories
*(Peischl et al., JGR, 2012)*

- **Motivation**: Accurate emission information required to predict AQ and climate change
- **Findings**: Observed fluxes typically 3x larger than inventories
- **Response**: Extend observations to capture temporal and spatial variability
CSD’s new mobile platform for extended observations

Instrumented 15-passenger 2-passenger van to quantify agricultural emissions

**Versatile and powerful infrastructure**
- Operate instruments for hours on battery power
- Seamless transition between power sources allows long duration, continuous measurement
- Easy to reconfigure for new instruments
- Detailed characterization of emission sources

**Current payload**
(commercial and custom)
- nitrous oxide
- methane
- ammonia
- CO, CO₂
- NO, NO₂, NOy
- ozone
- bio-aerosol
First results: Ammonia and methane from feedlots in NE Colorado

Experiment:
Drive around several feedlots repeatedly
Diurnal variability
(in collaboration with Princeton U., Aerodyne)
Seasonal variability

Large (!) mixing ratios

Use enhancement ratios to compare with inventories

• Critical to assess inventories and resolve discrepancies with observations
• Ammonia to methane emissions ratio vary with temperature and time of day
Future directions for CSD’s mobile van

• Quantify emissions flux to the atmosphere:
  – incorporate remote sensing or UAS to determine winds aloft and boundary layer height
  – vertical wind measurements, tracer release
• Partner with industry to identify practices that reduce emissions
  fertilizer lost to the atmosphere = $ lost
• Valuable platform for testing and deploying new instrumentation