Greenhouse Gas Flux Measurements of Agricultural Systems

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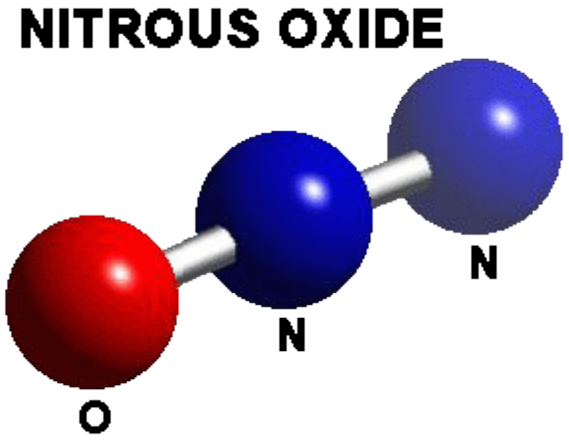
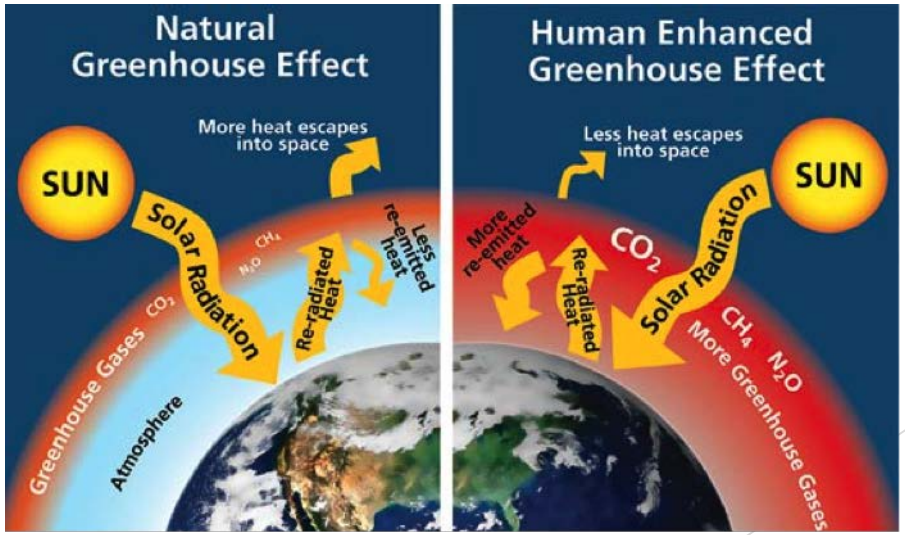
Importance of Nitrous Oxide (N2O)

- 4th most prevalent greenhouse gas
- 298 times the atmospheric warming ability of CO2 (IPCC 2013)
- Dominant stratospheric ozone depleting substance after the phase out of chloro-fluorocarbons



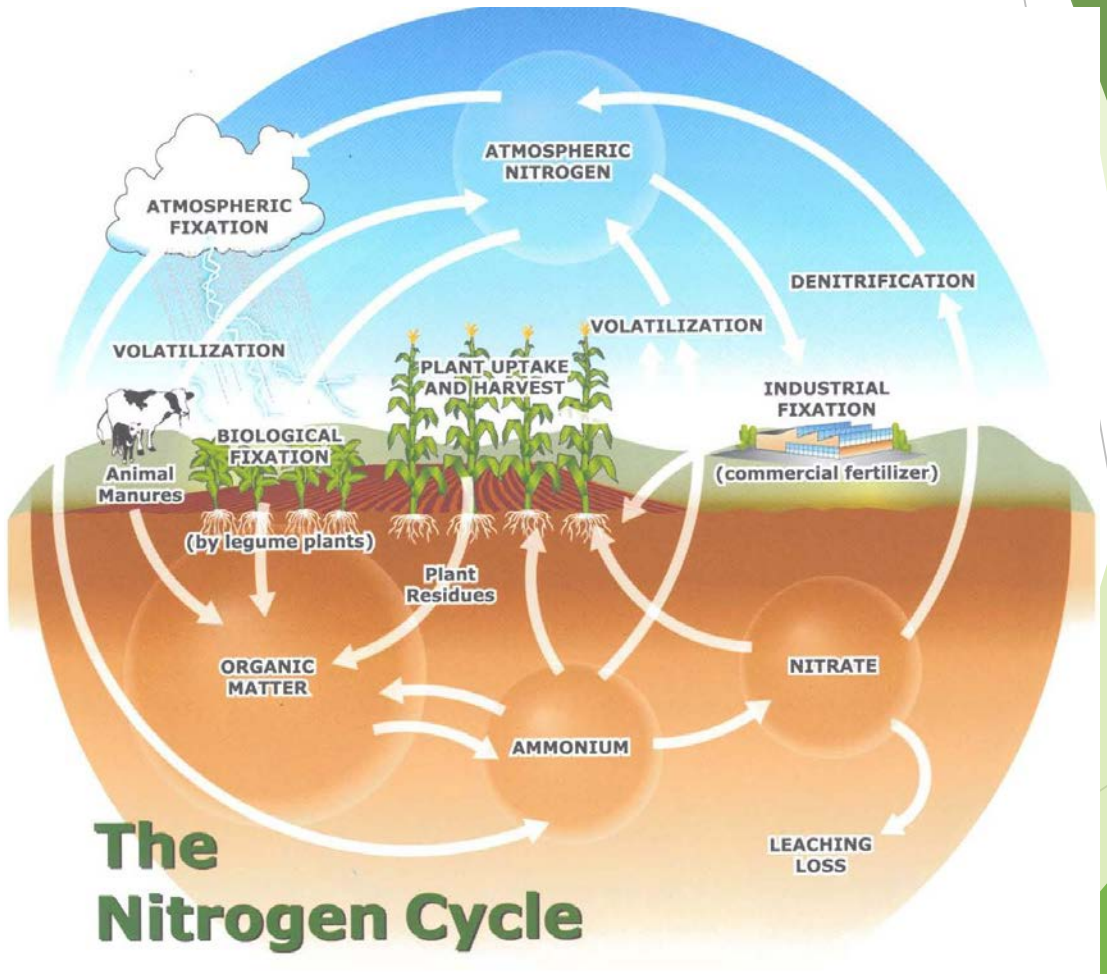
From: terrificscience.biz



From:c2es.org

Nitrous Oxide and Agriculture

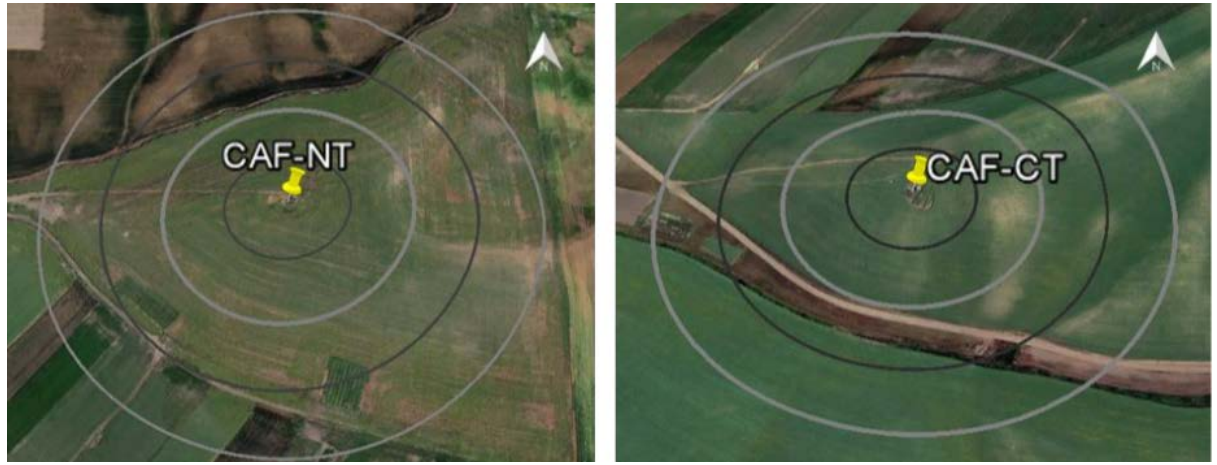
- 38% of N2O emissions in the atmosphere are anthropogenic
- 75% of anthropogenic N2O emissions come from soil management
- Microbial processes that naturally produce N2O are enhanced with commercial fertilizer application
- N2O atmospheric concentrations increased 19% since pre-industrial times
  - 270 ppb to 320 ppb



From: agricdemy.com

Past REACCH Nitrous Oxide Measurements:

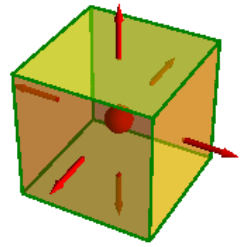
- Sarah Waldo measured N2O fluxes at conventional tillage and no-tillage fields using both automated static chambers and the flux gradient micrometeorological techniques to determine how different agricultural management practices affected N2O emissions
- Chamber and gradient measurements were taken in parallel



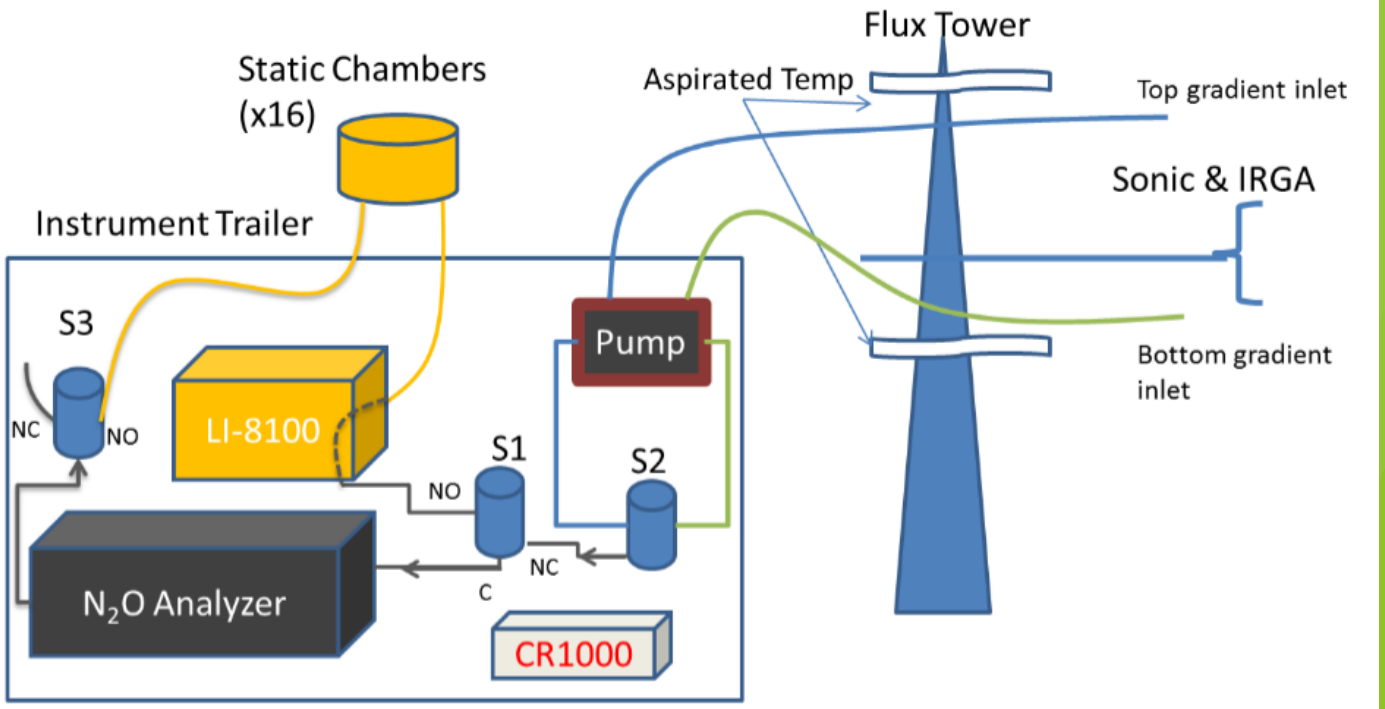
From: Waldo et. al

Past REACCH Nitrous Oxide Measurements: Flux Gradient Micrometeorological Technique

- Is a field scale measurement
- Works by determining the difference concentration difference between two inlet heights
- Use this measurement to determine the flux of N2O into the atmosphere



From: rakeshkapoor.us

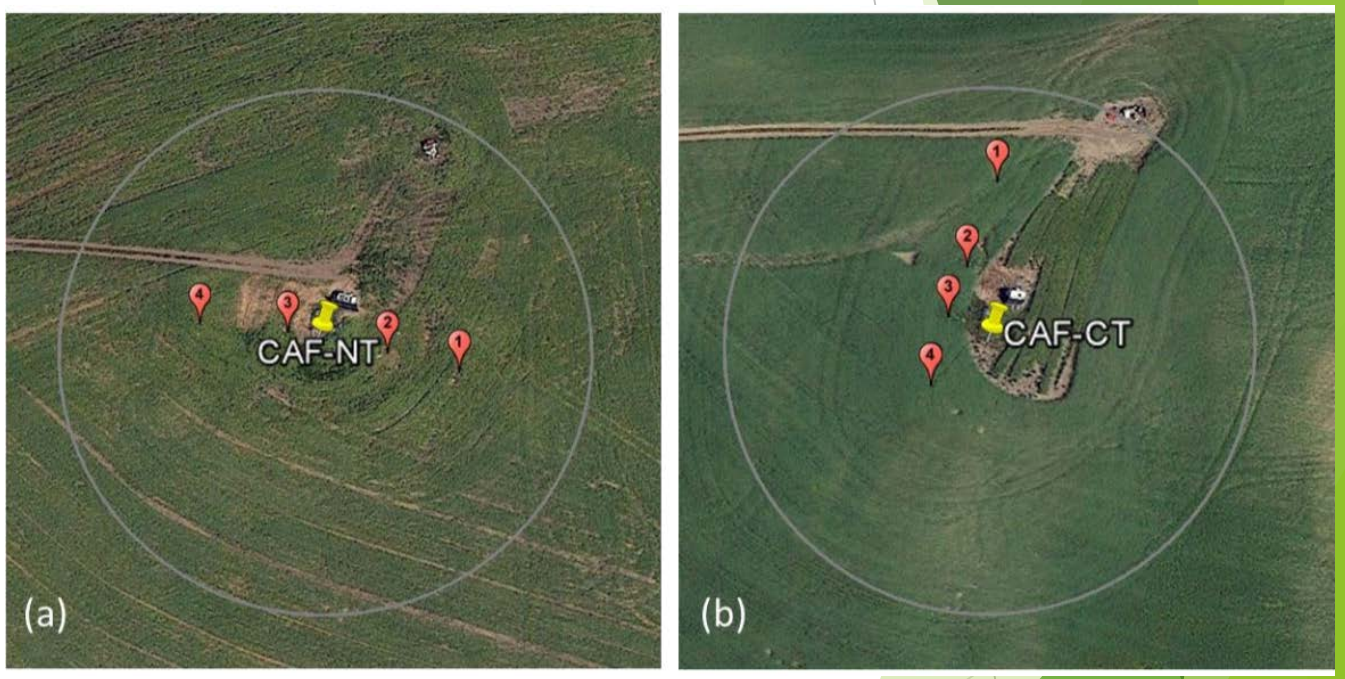


From: Waldo et. al

Past REACCH Nitrous Oxide Measurements: Static Chamber Technique

- Is a point measurement
- Works by putting a chamber over the soil and analyzing trace gas build up over time to determine flux

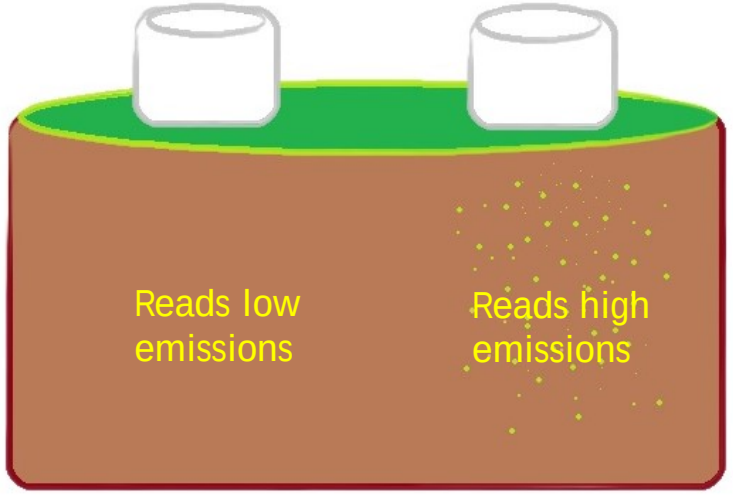
From: licor.com



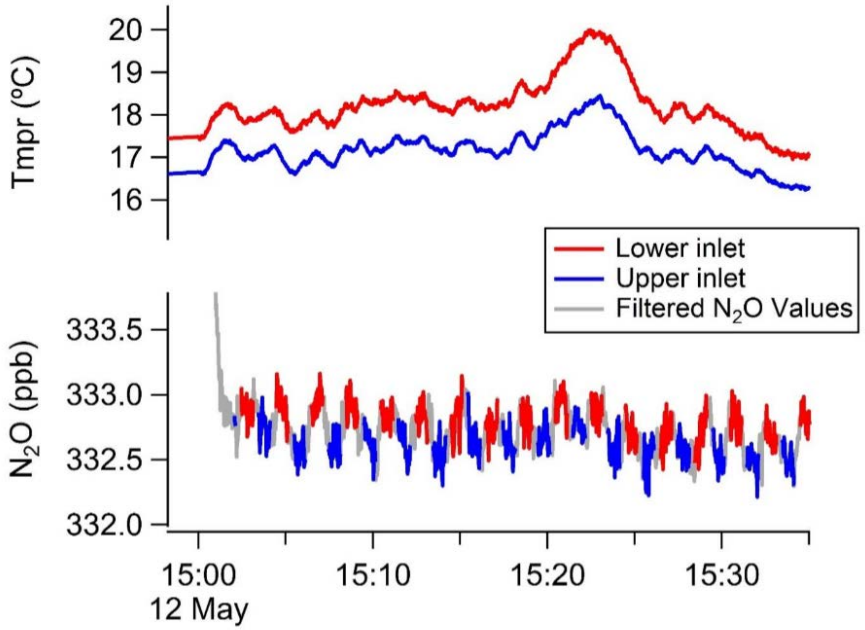
From: Waldo et. al

Challenges with Nitrous Oxide Measurements

- Soil gas flux chambers are effective at detecting very small emissions at a point but have high spatial variability



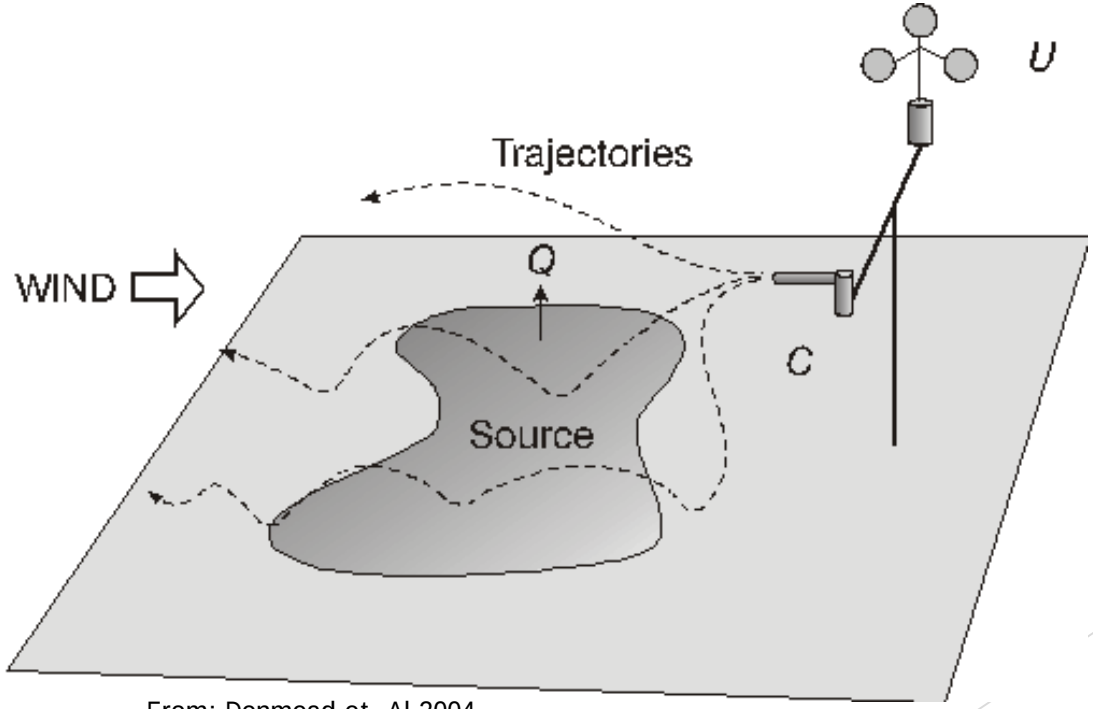
- Gradient flux measurements are field scale but there are issues with instrument sensitivity for N2O



From: Waldo et. al

Project Focus

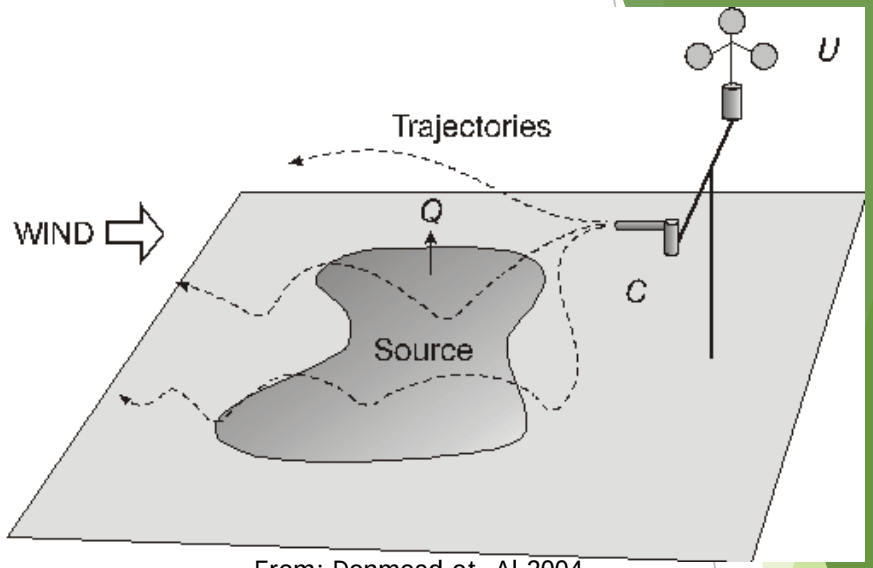
- Can we use backward Lagrangian stochastic modeling to simulate nitrous oxide field emissions?
- Input tower N2O concentrations to estimate field emissions
- Expanding nitrous oxide emissions estimates to other fields



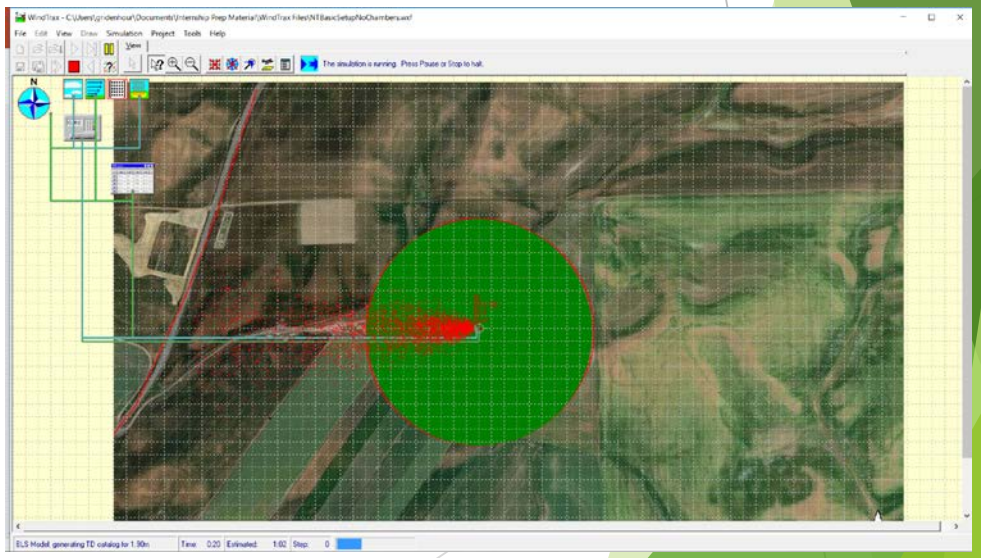
From: Denmead et. Al 2004

WindTrax: How it works

- Windtrax uses Lagrangian stochastic modeling to simulate the transportation of trace gases from the source(s) that emit them.
- “Lagrangian”: model releases individual particles and follows their distinct paths through the air
- “Stochastic”: model represents the random turbulence of the atmosphere by introducing random numbers into the calculations that determine the particle’s path

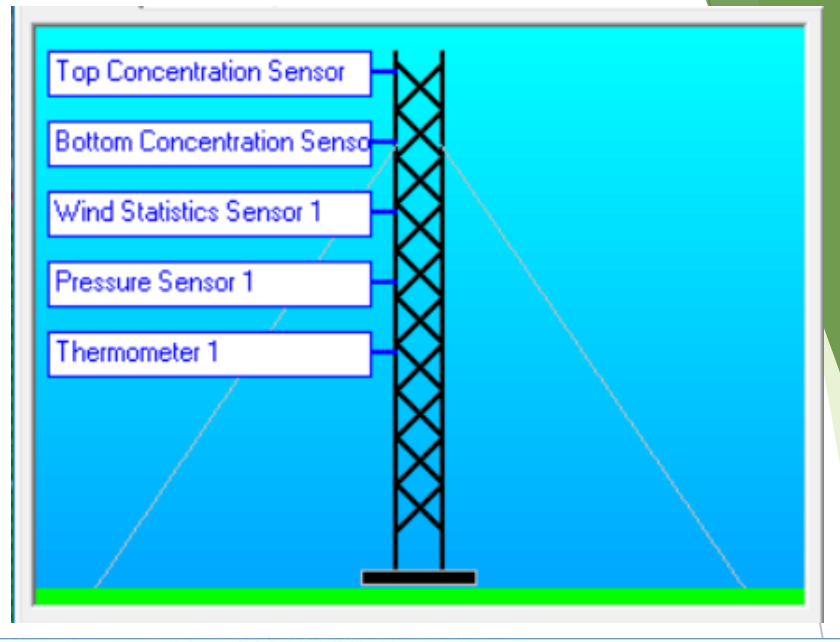


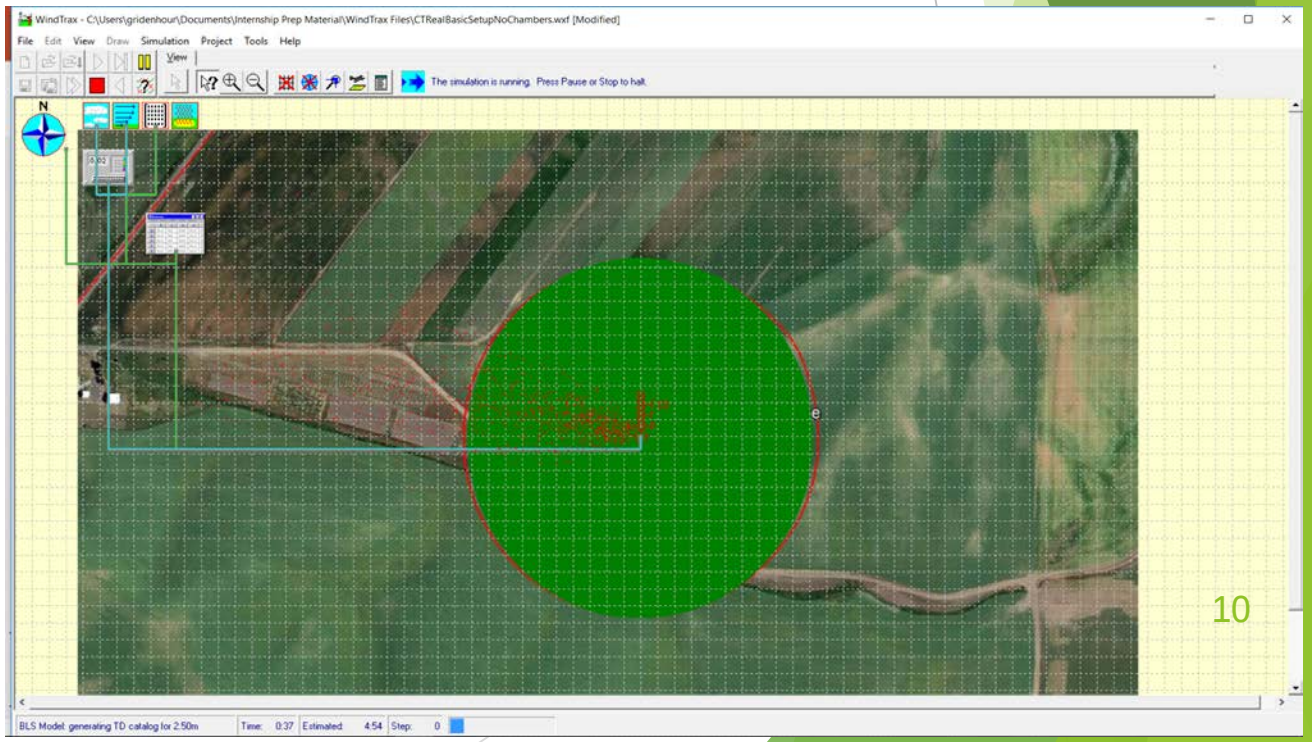
From: Denmead et. Al 2004



Model Setup

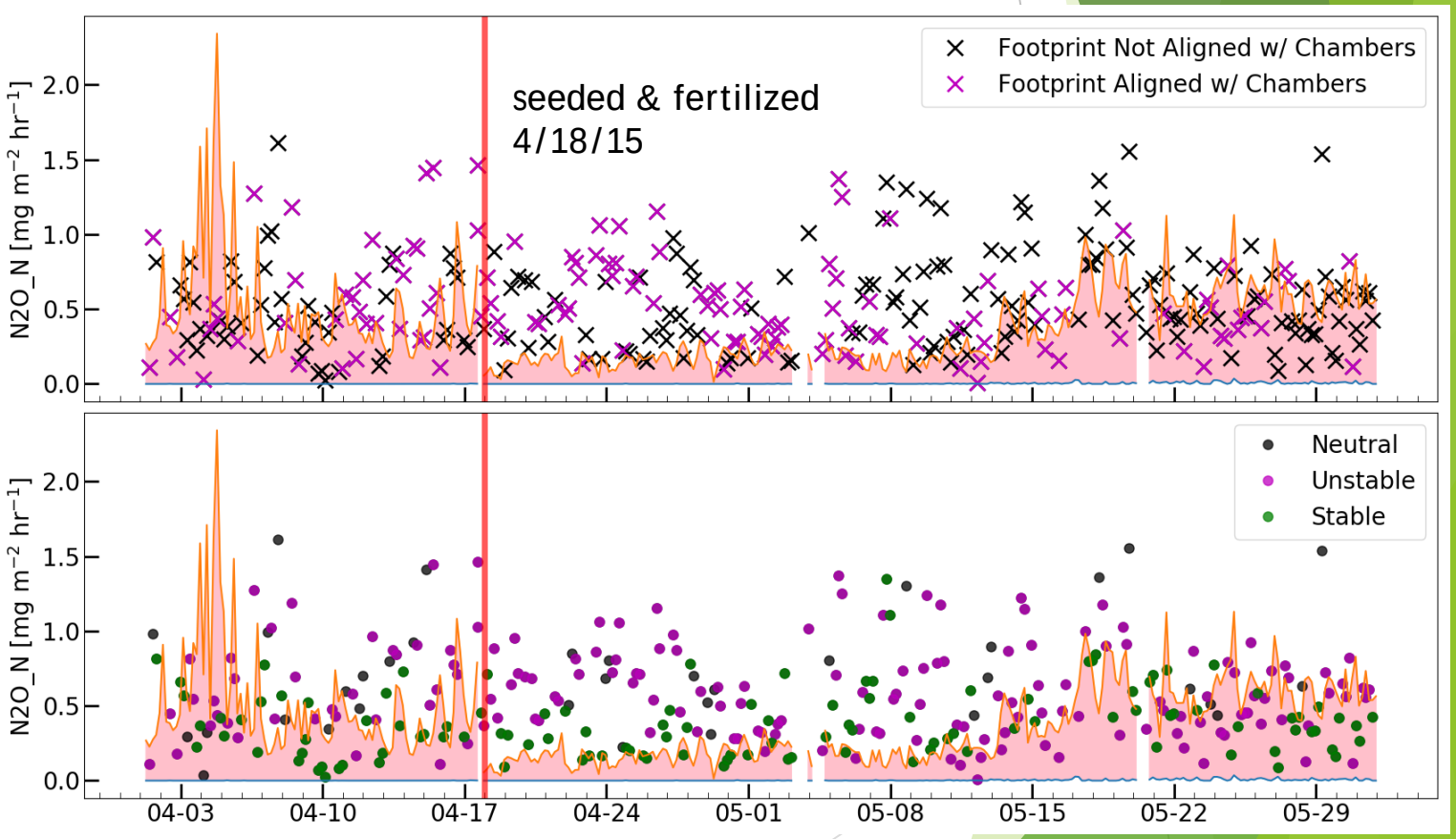
- Set up the model by placing atmospheric sensors that represent our field sensors
- A large field area source was placed to represent all possible flux tower footprints
- Elevation, background concentration and crop height were inputted through the surface and atmospheric property parameters
- Estimated background concentration by doing a frequency distribution of the concentration values and looked at the bottom 5%





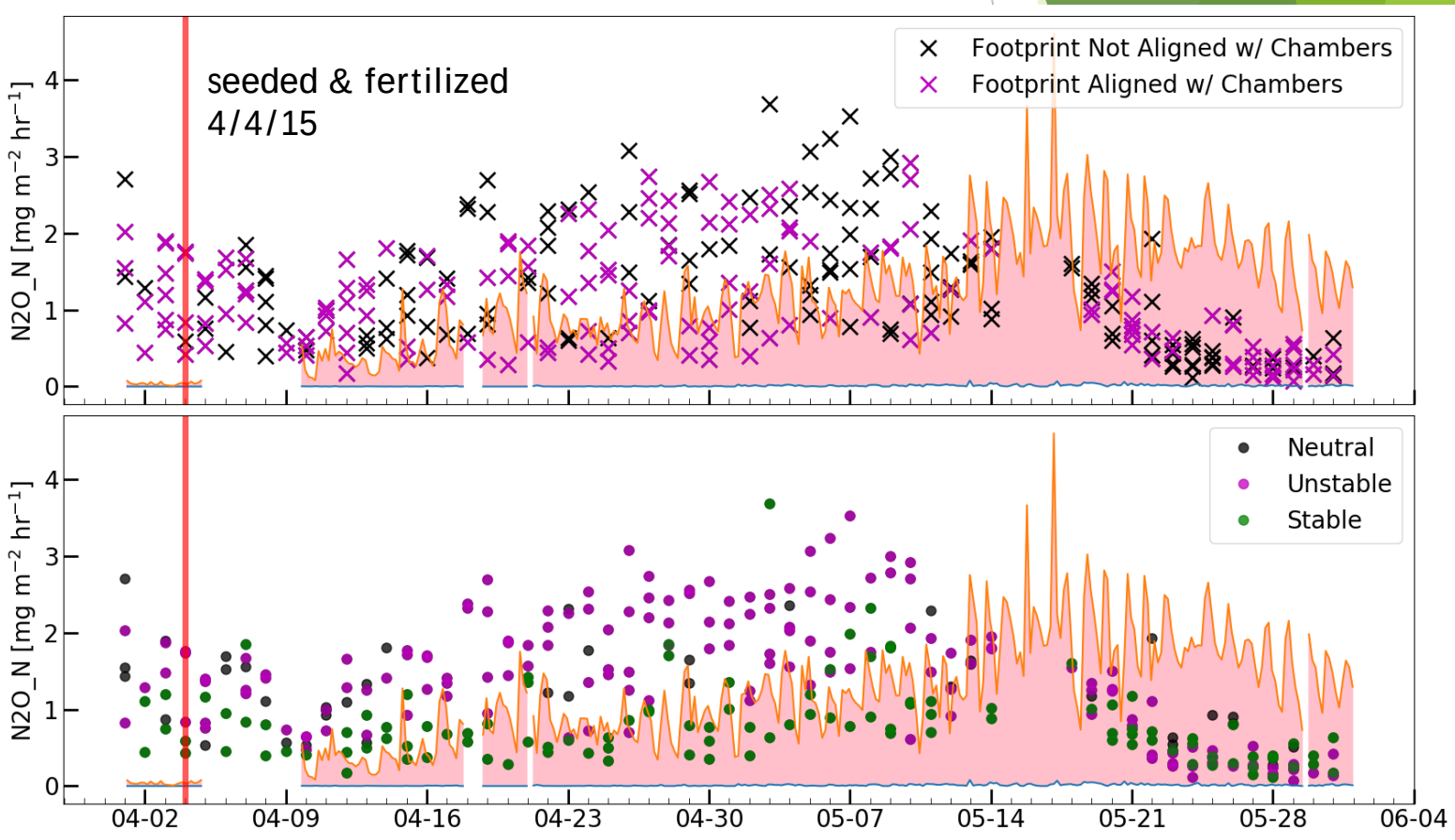
Results No Till 4/1/2015-5/31/2015

- Appears that emissions decrease after seeding and fertilization
- Stable estimations are closer to chamber emissions



Results Conventional Till

- A significant increase in emissions after seeding and fertilization
- Stable estimations are closer to chamber emissions

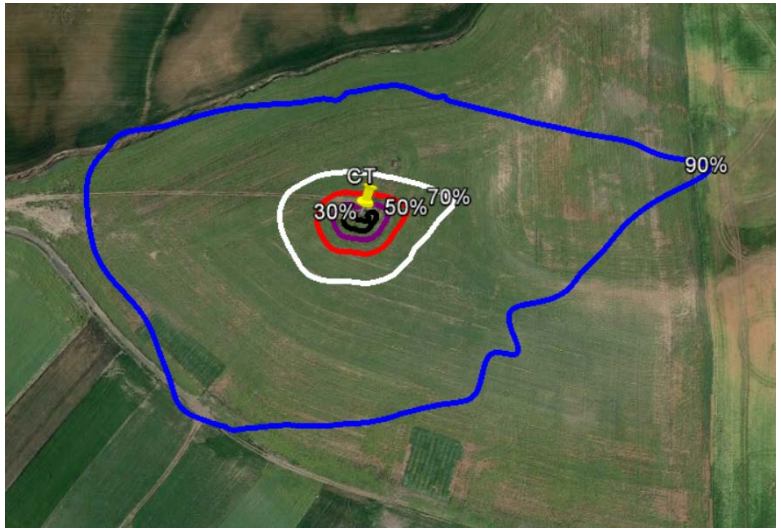


Results No Till: Box and Whisker

- Windtrax CT Mean: 1.217
- Windtrax CT Range:0.071- 3.682
- Average Chamber CT Mean: 1.102
- Average Chamber CT Range: 0-3.020
- Windtrax NT Mean: 0.844
- Windtrax NT Range: 0.012 -2.533
- Average Chamber NT Mean: 0.016
- Average Chamber NT Range:0 -0.168

Limitations of WindTrax

- It treats everything as a flat field
- Inflexibility of WindTrax input data and setup
- Simplistic turbulence
- No chemistry considerations



Moving Forward

- Experimentally measure background concentration at the field site
- Investigate a model that can better simulate non-flat agricultural fields
- Incorporate soil inputs
- Advances in instrumentation and more robust set up
- Longer data periods

From: fineartamerica.com

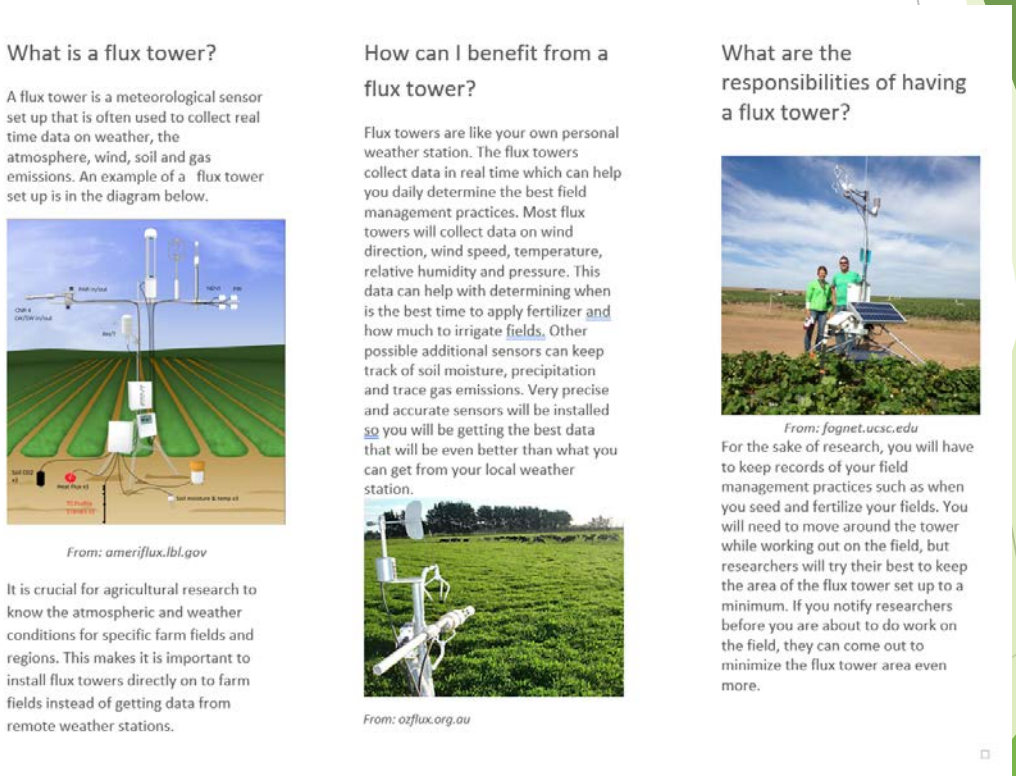
Extension Project: Audience & Goal

- Audience: farmers who have fields that can have flux towers
- To fill the flux tower knowledge gap between farmers and researchers
- To motivate farmers to agree to flux tower installation

From: fognet.ucsc.edu

Extension Project: Dissemination

- Created an informational brochure about flux towers to give to growers
- Distributed through professors who work with flux towers who are involved in agricultural research



What is a flux tower?

A flux tower is a meteorological sensor set up that is often used to collect real time data on weather, the atmosphere, wind, soil and gas emissions. An example of a flux tower set up is in the diagram below.

From: ameriflux.lbl.gov

It is crucial for agricultural research to know the atmospheric and weather conditions for specific farm fields and regions. This makes it is important to install flux towers directly on to farm fields instead of getting data from remote weather stations.

How can I benefit from a flux tower?

Flux towers are like your own personal weather station. The flux towers collect data in real time which can help you daily determine the best field management practices. Most flux towers will collect data on wind direction, wind speed, temperature, relative humidity and pressure. This data can help with determining when is the best time to apply fertilizer and how much to irrigate fields. Other possible additional sensors can keep track of soil moisture, precipitation and trace gas emissions. Very precise and accurate sensors will be installed so you will be getting the best data that will be even better than what you can get from your local weather station.

From: ozflux.org.au

What are the responsibilities of having a flux tower?

From: fognet.ucsc.edu

For the sake of research, you will have to keep records of your field management practices such as when you seed and fertilize your fields. You will need to move around the tower while working out on the field, but researchers will try their best to keep the area of the flux tower set up to a minimum. If you notify researchers before you are about to do work on the field, they can come out to minimize the flux tower area even more.

Thank you for your attention!
Any Questions?