Development of an Improved Method for Measuring Nitrous Oxide Emissions from Soils in the Southeast

Introduction

Nitrous Oxide Production

A microbial process called denitrification produces N\textsubscript{2}O when water from precipitation or irrigation fills soil pores and creates an anaerobic environment. Through denitrification, nitrate (NO\textsubscript{3}\textsuperscript{-}) can be converted to and released as N\textsubscript{2}O gas. Researchers often measure N\textsubscript{2}O emissions 12 to 72 hours after a rain event. It is often assumed measurements are being made at the peak of the temporal emissions curve. However, the magnitudes and patterns of N\textsubscript{2}O temporal emissions curves are largely unknown.

- Assumptions are being made at the peak of emissions leads to uncertainty when calculating cumulative emissions.

Flow-Through Chamber Method

- A qualitative index of the temporal emissions curve was recorded, which was then used to inform adjustments to cumulative flux calculations from static chamber data.
- An infrared gas analyzer was housed in a trailer at the field site to continuously measure the concentration of N\textsubscript{2}O in the gas stream drawn from flow-through chambers positioned at multiple group locations in a no-till, conventional agro-ecosystem.
- Sampling cycled between four chambers and one ambient air sample every 2.5 hours.
- Chamber lids were moved after rain events to fresh monitoring location anchors installed prior to the start of the monitoring period.

Results & Discussion

- We used three methods to derive an estimate of cumulative N\textsubscript{2}O loss from April 30 to Sept. 3, 2015.
- To estimate a peak flux value, we modeled the decay in emissions using a simple exponential decay curve:

\[
\text{Flux (mg N}_2\text{O/ha/hr)} = A e^{-Bx}
\]

where A = peak flux, B is constant and x = time since peak flux

- Using only static chamber data and linear interpolation and integration to calculate cumulative flux potentially overestimates total flux.

Adjustments to Cumulative Flux Calculations

- The index of the temporal emissions curve from the continuous flow-through chamber data provides an estimate of when the emissions event started.
- Adding a “static chamber” measurement at the start of the emissions event reduced the tendency to overestimate flux, but resulted in potential underestimation of cumulative flux.

Objective

- To reduce uncertainty in cumulative N\textsubscript{2}O flux estimates due to temporal variability

Approach:

- Use static chamber method for quantitative N\textsubscript{2}O flux values
- Use a continuous-flow chamber method to record an index of the temporal emissions curve that will be used to qualitatively inform adjustments static-chamber measurement based cumulative N\textsubscript{2}O flux

Cumulative Flux Calculation

- Interpolate between flux data points. Each point represents one flux estimate derived from five static chamber measurements.
- Realistically, there is often poor characterization of the temporal emissions curve (Fig. 1). Leading to uncertainty in cumulative flux estimates.
- We need a way to characterize the temporal emissions curve and reduce uncertainty.

Future Work

- Use continuously recorded index of the temporal emissions curve to adjust quantitative estimates of the cumulative N\textsubscript{2}O flux from static chamber measurements, which may not produce absolute differences between flux calculation methods.
- However, method 3 corrected for the tendency to underestimate cumulative flux from method 1 and the tendency to underestimate cumulative flux in method 2.

Conclusion

- Use automated chamber lids to decrease effects on chamber environment
- Quantitatively measure flux with continuous-flow-through system

Flow-Through Chamber Method

No Rain

Rain

Observation

Flow-through Chambers

- This is an example of the flow-through chamber data from one chamber.
- The net concentration of N\textsubscript{2}O in the headspace peaked and diminished following the same trend as measured with the static chamber N\textsubscript{2}O.

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