A Comparison between the Tower-Based Gradient Method and the Automated Chamber Method for Measuring N₂O Fluxes from an Agricultural Field
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Introduction

• More than half of anthropogenic N₂O emissions result from agricultural activities.
• Drainage water management (DWM) reduces nitrate export by enhancing denitrification, but will it increase N₂O emissions?

Objectives

• Quantify soil N₂O emissions in control and DWM treatment plots.
• Compare auto-chamber and micrometeorological gradient methods for N₂O flux measurement using fast response instruments in situ.

Experimental Design

• The fields were planted in corn on April 25, 2019 and fertilized with 22 kg/ha Urea Ammonium Nitrate (UAN) on April 25 and 202 kg/ha UAN on May 24.
• A 3 m tall tower was installed in each of four fields, containing a CSAT3B three-dimensional sonic anemometer (Campbell Scientific) and a pair of upper and lower inlets, allowed for near-continuous gradient flux measurements using an Aerodyne Quantum Cascade Laser (QCL).
• Four Eosense closed dynamic automated chambers (eoaCC) and a multiplexer (eosMX) were installed near one tower and connected to a Picarro Cavity Ring-Down Spectroscopy (CRDS) gas analyzer (G2308).

Flux Calculation

The basic calculation for the flux ($F_i$) is:

$$F_i = -\frac{dC}{dz}$$

where $dC$ is the concentration difference and $dz$ is the height difference between the two intakes. $x$ is the diffusion coefficient, as calculated in Wagner-Riddle et al. (1996).

Potential N₂O emissions

Nitrate leaching

References


Fluxes from the two methods were linearly correlated ($R^2 = 0.54$), but the slope ($1.29 \pm 0.08$) and y-intercept ($48.3 \pm 19.2$) indicate that the chambers generally estimated higher fluxes.

Aggregating over the measurement period, the automated chamber estimate was $2.5 \pm 0.1$ kg N₂O-N/ha and the tower-based gradient estimate was 1.3 kg N₂O-N/ha in 19 days.

Possible explanations include: (1) the tower footprint includes area (~4%) covered by ditches and could extend beyond the field at times; (2) the small number of chambers may have sampled an area of above average flux and (3) unknown measurement bias or interpolation error in one or both methods.

Summary

• To our knowledge, this is one of the first tower/chamber comparisons of N₂O fluxes, presumably due to lack of available N:
• Later in the same year, wet-up events did not produce increased N₂O fluxes, since these sensitive, fast response instruments have become available. While they demonstrated similar temporal patterns of pulsed emissions after spring rains, the chamber estimate was higher for unknown reasons.
• There were differences among plots, but the DWM treatment had no significant effect on N₂O fluxes. If confirmed by further research, DWM can be used to reduce nitrate leaching without increasing N₂O emissions.

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