Soil-to-Atmosphere Greenhouse Gas Emissions from High- and Low-Input Turf Systems of Central Kentucky

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Research Question: Are there differences in trace gas emissions between homeowner lawn types and maintenance regimes?

Hypotheses

- **H_1:** Over the entire season, the high maintenance turf will have both higher CO_2 and N_2O flux rates than the low maintenance turf.
- **H_2:** Fertilizer applications to the high maintenance turf will stimulate a spike in N_2O, NH_3, and CO_2 loss.

Background

- Different turf and management types may effect trace gas fluxes.
- Turf covers 20 million Ha in the United States.
- Mostly concentrated in urban areas.
- Turf systems release trace greenhouse gases:

Flux out of the Soil

CO_2 – respiration (root & microbial)	**CO_2** – autotrophic photosynthesis
N_2O – denitrification	**N_2O** – used as intermediate in N pathways
NH_3 – Ammonia volitilization	**NH_3** – taken up by ammonia oxidizing bacteria

Flux into the Soil

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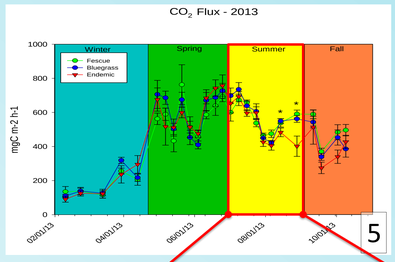
Figure 1. General diagram of trace gas movement in and out of soil. Measured flux is the net flux out of the soil.

Results



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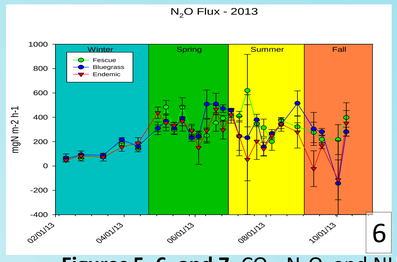

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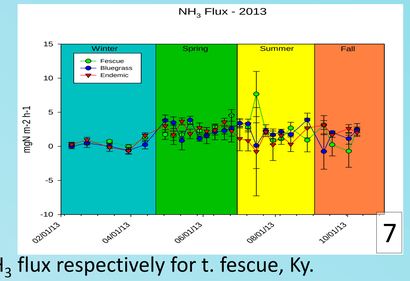

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Figures 5, 6, and 7. CO_2, N_2O, and NH_3 flux respectively for t. fescue, Ky. bluegrass, and endemic stands for the whole growing season.

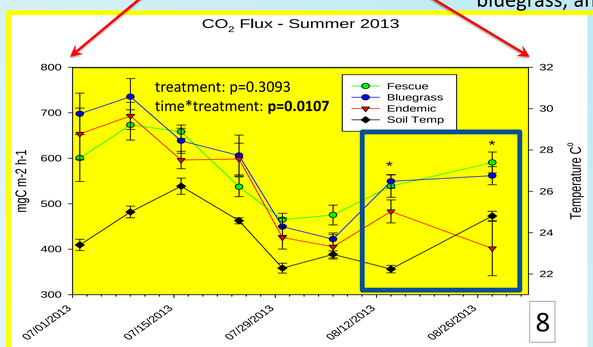

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Figure 8. Significant time*treatment difference in CO_2 flux at the end of the summer.

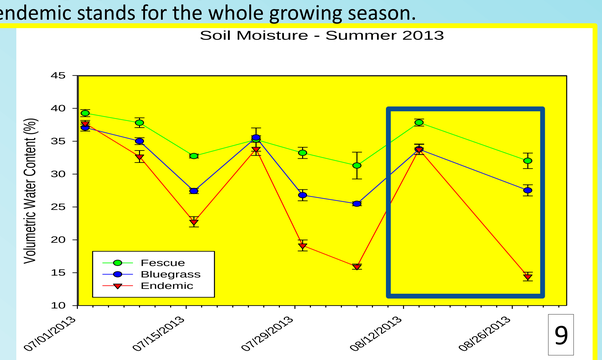

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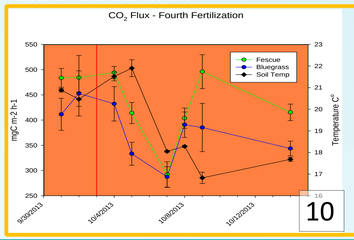
Figure 9. Soil moisture by treatment for the same period as the significant CO_2 flux difference.



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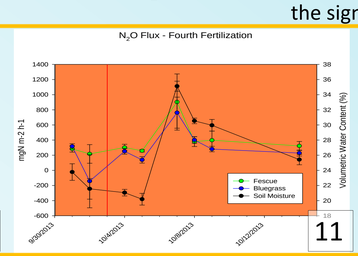

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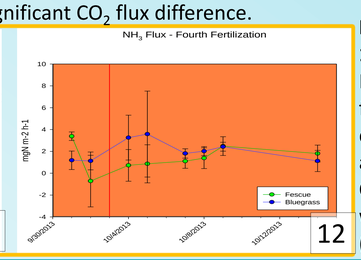

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Figures 10, 11, and 12. CO_2, N_2O, and NH_3 Flux for October fertilization; red line denotes N application date. The October application was the largest (97.64kg ha^{-1}).

Conclusions

- **C_1:** High maintenance turf generally did not have higher CO_2 and N_2O fluxes (**Figures 5 and 6**), except when there were extended large differences in soil moisture between the high and low maintenance stands.
- **C_2:** High maintenance turf did not show any spikes in CO_2, N_2O, or NH_3 in response to fertilization (**Figures 10, 11, and 12**), which could be due to high levels of plant uptake.

References

- Bartlett, M.D. and I.T. James. 2011. Are golf courses a source or sink of atmospheric carbon dioxide? A modelling approach. Proceedings of the Institution of Mechanical Engineers Part P-Journal of Sports Engineering and Technology 225: 75-83. doi:10.1177/1754337110396014.
- Braun, M., Y. Bai, B. McConkey, R. Farrell, J.T. Romo and D. Pennock. 2013. Greenhouse gas flux in a temperate grassland as affected by landform and disturbance. Landscape Ecol 28: 709-723. doi:10.1007/s10980-013-9878-9.
- Townsend-Small, A. and C.I. Czimczik. 2010. Carbon sequestration and greenhouse gas emissions in urban turf. Geophys. Res. Lett. 37. doi:10.1029/2009gl041675.

Design & Maintenance

- All treatments were mowed to 7.6cm when the three replicates average over 10.2cm.
- High maintenance: irrigation, fertilization, and pesticide.
- Low maintenance: no inputs.
- Four Lawn - *Maintenance* Types:
  - tall fescue – high
  - Kentucky bluegrass – high
  - zoysia grass – low
  - "endemic" multi-species – low
- Plots are 18.28x18.28m with 18.28m of runway between each plot.

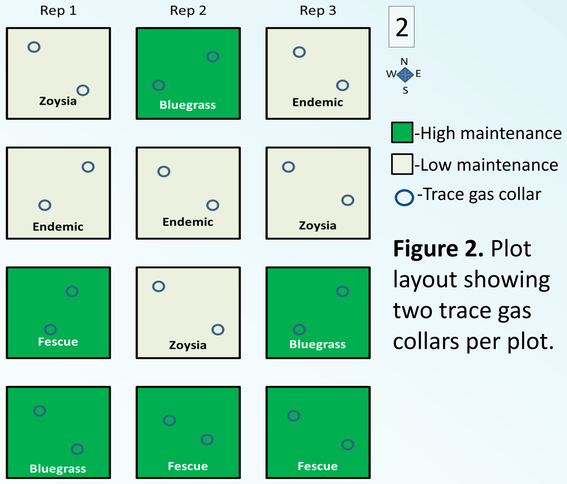

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Figure 2. Plot layout showing two trace gas collars per plot.

Sampling

- Every other week during cool season
  - February 10 – April 13, 2013
- Every week during warm season
  - May 7 – October 9, 2013
- Every day surrounding a fertilization event (4 total) – starting two days before, and continuing every day for ~ 2 weeks


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Figure 3. Picture showing the field sampling instruments: INNOVA photoacoustic gas analyzer and flux chamber.
Figure 4. Trace gas collars were installed permanently in field, ~2cm above ground and 13cm below ground.