Long-term nitrous oxide (N_2O) fluxes in the upper Midwest USA: A comparison between annual and perennial systems.

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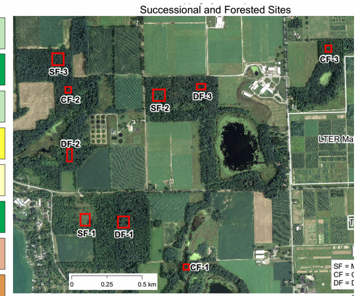
Background and objective

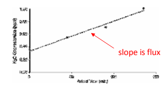
- Nitrous oxide (N_2O) plays a significant role in the greenhouse gas (GHG) balance of the atmosphere and stratospheric ozone depletion.
- Agricultural soils are the largest source of anthropogenic emissions of N_2O to the atmosphere.
- Understanding the controls and dynamics of emissions of N_2O is essential for: Developing mitigation opportunities, Predicting future climate impacts, and Closing global N_2O budget, currently unbalanced.
- Sporadic nature of soil N_2O fluxes makes their evaluation and prediction difficult.

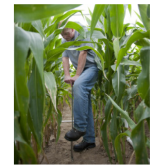
We've used 20 years of measurements of soil N_2O emissions, together with numerous environmental and soil variables to determine the effect of different agricultural and land management practices on soil N_2O emissions.

Study site and methods

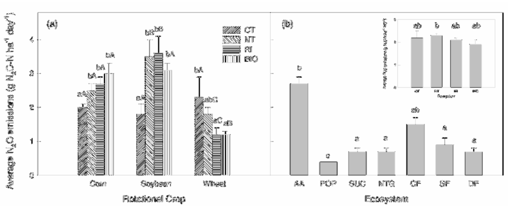


Bi-weekly measurements 1991 - 2011

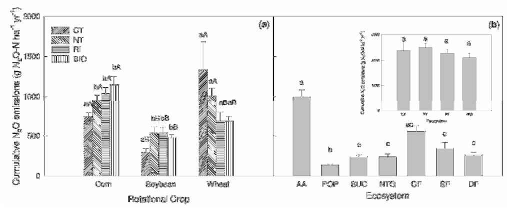




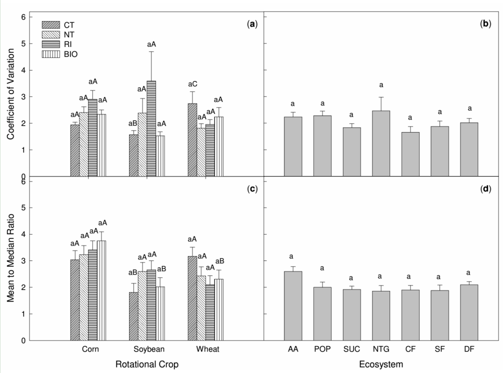
Results



Daily average soil N2O emissions between years 1991 and 2011 (mean ± standard error). **a**) annual ecosystems, emissions for specific crop year and **b**) perennial ecosystems, emissions for an average calendar year.



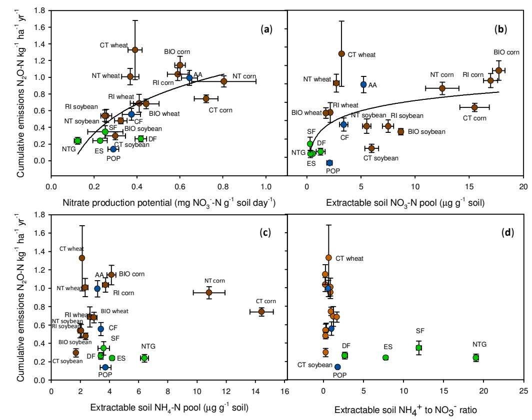
Average annual cumulative soil N_2O emissions **a**) annual ecosystems, emissions for specific crop year; **b**) perennial ecosystems, emissions for an average calendar year.



Coefficient of variation (**a**, **b**) and mean to median ratio (**c**, **d**) of daily average soil N_2O emissions.

System	Measured	Surplus	IPCC	Yield Scaled
	Cumulative emissions			
	kg N_2O-N ha^{-1}			*g N_2O-N kg^{-1} N uptake*
Conventional tillage				
Corn	0.74 (0.05)	1.48	1.46	5.24
Soybean	0.30 (0.05)	2.15	0.35	1.32
Wheat	1.33 (0.35)	1.44	1.04	17.18
No-Tillage				
Corn	0.95 (0.07)	1.58	1.47	6.18
Soybean	0.54 (0.08)	2.15	0.37	2.57
Wheat	1.01 (0.10)	1.44	1.09	11.09
Reduced Input				
Corn	1.04 (0.08)	1.75	1.34	6.83
Soybean	0.54 (0.07)	2.19	0.45	2.41
Wheat	0.69 (0.11)	1.87	0.63	7.86
Biologically managed				
Corn	1.14 (0.11)	1.94	0.93	9.32
Soybean	0.48 (0.03)	2.23	0.37	2.22
Wheat	0.68 (0.06)	2.08	0.24	10.74

Cumulative N_2O emissions from the annual ecosystems during the growing season as estimated using linear interpolation between days of measurement, surplus, IPCC, and yield-scaled approaches.



Relationships between cumulative soil N_2O emissions and **a**) NO_3^- production potential, **b**) extractable soil NO_3^- pool, **c**) extractable soil NH_4^+ pool, and **d**) ratio between extractable soil pools of NH_4^+ and NO_3^-. Ag. systems, Perennial crops, Suc. systems.

Conclusions

- Ecosystems under more intensive management have higher N_2O emissions.
- Cumulative soil N_2O emissions are correlated with soil NO_3^- pool and NO_3^- production potential and decreasing with decreasing management intensity and increasing plant community complexity.
- Fluxes estimated by IPCC based approach are closer to measured soil N_2O emissions then those estimated using surplus approach.
- All studied ecosystem have similar emission variability.

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