Validation of DAYCENT Model Based on Daily Measurements of Nitrous Oxide Emission from a Corn Field

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INTRODUCTION AND OBJECTIVES

Accurate assessment of nitrous oxide emission (N_2O) from the ecosystem requires continuous year-round and spatially extensive monitoring. Simulation models predict N_2O regional fluxes based on local climatic, soil and agricultural system input data. Implementation of models allows us to predict responses to climatic variability or changes in the soil and crop management. The DAYCENT model (Parton et al. 1998) is a useful tool in estimating nitrous oxide (N_2O) fluxes. However, the models should be validated against the results of instrumental measurements to verify and improve their performance. The purpose of the study was to compare measured N_2O fluxes from an experimental corn field with the predicted fluxes obtained by DAYCENT Model in the same soil, at the same weather and land management conditions.

METHODS

Field N_2O emissions were measured in four replicates at six hour intervals using an automated chamber and gas chromatograph. The measurements were taken over the period of DOY (day of year) 42 through DOY 254 of 2006. The chambers were installed in the corn field classified as a Canisteo fine-loamy, mixed, mesic Typic Haplaquolls located in Central Iowa. The soil had neutral pH and 25 g kg^{-1} of organic carbon. In 2005, prior to corn, soybeans were grown. After the soybean harvest the field was strip-tilled, and ammonia fertilizer was injected at the rate of 170 kg ha^{-1}. Corn was planted at the beginning of May. For DAYCENT validation the average field values of N_2O emissions from four daily measurements and four replications were used. The DAYCENT simulation was performed using local climatic soil and agricultural parameters.

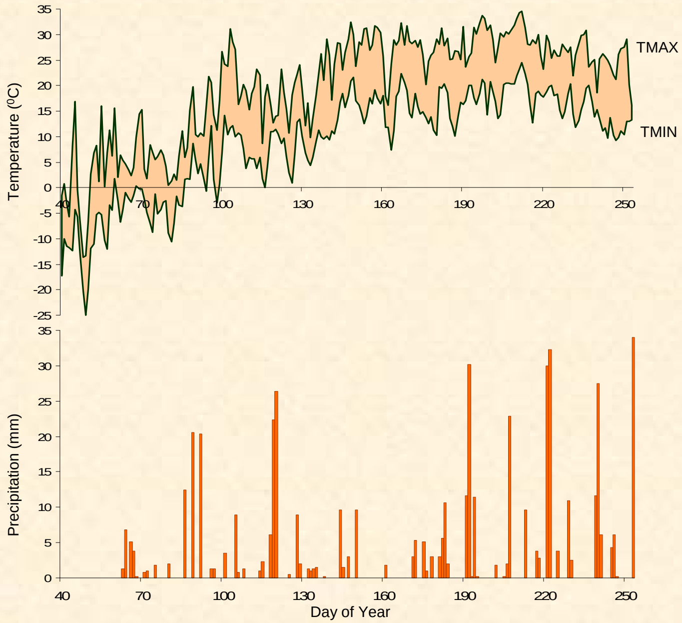


Fig. 1. Daily air temperature and precipitation over measurement period

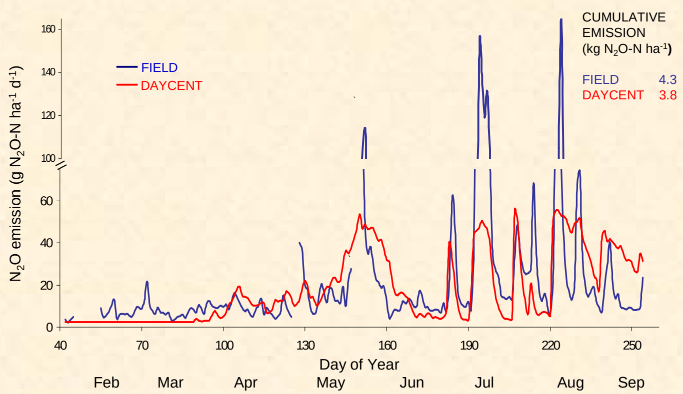
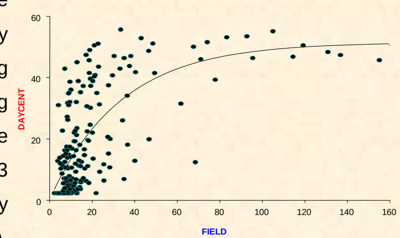


Fig. 2. Measured and predicted by DAYCENT daily nitrous oxide emission

RESULTS

In general, field measurements of N_2O emission ware in agreement with the fluxes predicted by DAYCENT (r = 0.63) (Figs. 2 and 3). However, the discrepancies were noted when comparing daily N_2O emissions. In the second half of February and in March the field N_2O emission responded to variations in minimum and maximum air temperature, whereas DAYCENT prediction kept the N_2O flux on the same low level (Figs.1 and 2). During April and May DAYCENT predicted slightly higher N_2O flux compared to that measured in the field (Figs 1 and 2). The largest discrepancies in daily N_2O fluxes were observed during the summer season following rain storm events, where measured emissions were 2-3 times higher than predicted by DAYCENT (Figs. 1, 2 and 3). The cumulative N_2O emissions for the whole measurement period of field monitoring and of DAYCENT were similar (4.3 and 3.8 kg N_2O-N ha^{-1}, respectively) (Fig. 2).



Equation: f = y0+a*(1-b^x)

	Coefficient	Std. Error	t	P
y0	9.9125	1.5914	6.2289	<0.0001
a	25907.72	1174283	0.0221	0.9824
b	1.0000	0.0007	1416.2826	<0.0001

Analysis of Variance

	DF	SS	MS	F	P
Regression	2	23263.3768	11631.68	67.91	<0.0001
Residual	210	35964.2125	171.2582		
Total	212	59227.5893	279.3754		
R = 0.626	Rsqr = 0.392		Adj Rsqr = 0.386		

Fig. 3. Nonlinear regression between field measured and DAYCENT predicted N_2O emission (g N_2O-N ha^{-1} d^{-1})

CONCLUSIONS

1. The cumulative N_2O emission predicted by DAYCENT was in agreement with cumulative N_2O emission obtained from field automatic chambers.
2. There were large discrepancies between DAYCENT'S predicted and field daily N_2O emissions following rain storm events during the summer.

REFERENCES

Parton, W.J., Hartman, M.D., Ojima, D.S., and D.S. Schmiel. 1998. DAYCENT: its land surface submodel-description and testing. Glob. Planet Chang. 19, 35-48.

This work contributes to the USDA ARS GraceNet Project

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