Adapting Century and DNDC for California

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Two Models

DayCent vs. DNDC

DayCent

Started as a C model using slow dynamics. Added daily water and N model much later.

Legacy:

More flexibility in crop systems
(customizable crop physiology and tillage options)

Less legit for fast N dynamics
(water dynamics still weekly/monthly)

DNDC

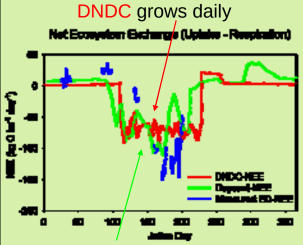
Started as an N model using fast dynamics. Added crop and soil C turnover.

Legacy:

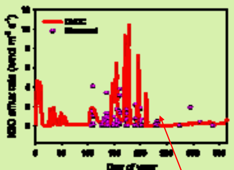
Less flexibility in crop systems
(repeated 1-year rotations only)

Less legit for soil C dynamics
(soil turnover constants hardly tested)

DNDC grows daily

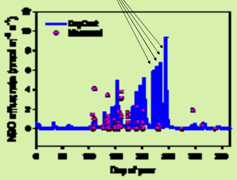


DayCent grows only weekly
(but yields more accurately)



In DNDC water can be meted out precisely on specific days

In DayCent water is applied in weekly doses for a month



Intro

Century and DNDC are two widely used ecosystem biogeochemistry models used to estimate carbon sequestration and greenhouse gas emission. However, neither of these models have been adapted to California's unique agricultural systems and validated against field measurements. Here we present the results of an effort to adapt DayCent (the daily version of Century) and DNDC, in order to estimate greenhouse gas emission and sequestration in California's agricultural sector. The models are capable of simulating yields, soil carbon, and nitrous oxide (N_2O) fairly accurately, but both models have inherent limitations which limit their accuracy.

Analysis

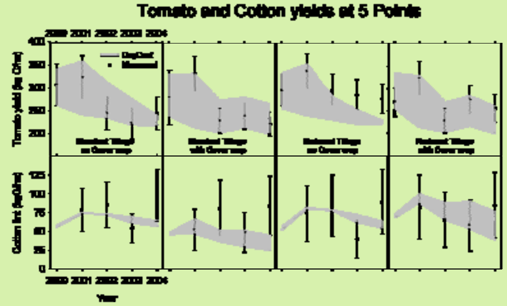
The overall goal of our project is to estimate the greenhouse gas budgets of agricultural systems in California, and in particular to identify the role alternative management practices may have in mitigating greenhouse gas emissions. Here, we present greenhouse gas budgets of several management alternatives at SAFS and 5-Points.

Agricultural systems in California appear to have more SOC than is expected from historic rainfall, due to irrigation and fertilization fostering increased organic matter additions. The study shows that cover crops are effective at turning agroecosystems into net carbon sinks. The increase in active soil C both from cover crops and reduced tillage is able to reduce denitrification, which is a major component of the greenhouse gas budget.

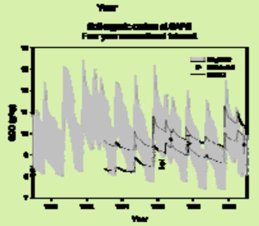
Altered yields and altered costs under alternative management imply prices of greenhouse gas mitigation on the order of $5-35/ton CO_2 equivalent. Reducing tillage with no cover crop is actually more profitable than standard, so appears to be the least-cost mitigation option.

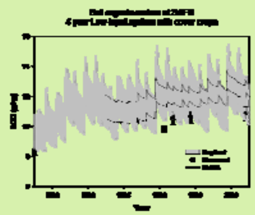
Two Experiments

SAFS and 5-Points



SAFS and 5 Points are two long-term cropping system experiments which offer a check on the accuracy of ecosystem simulations. SAFS was conducted in Yolo County from 1989-2001 and contrasts cover crop usage and organic matter additions. 5-Points is a current experiment located in Fresno County which examines cropping systems with reduced tillage and cover crops





Our study gauges model accuracy by comparing observations with simulations run across the range of soil texture measured at the study site. With few exceptions, observations overlap with the envelope defined by the maximum and minimum model runs. SOC dynamics in DayCent and DNDC differ from each other, but both are broadly consistent with the sparse measurements

Davis, Yolo County

Conventional

kg - /ha	Tomato	Saff	Corn	Bean	System
ΔSoil C	-358	878	656	-1295	-105
N2O	2.8	7.5	4.1	2.9	3.1
Fuel-C	448	173	219	276	278

tCO2e	Tomato	Saff	Corn	Bean	System
Soil C	2.4	3.2	2.4	4.7	0.4
N2O	2.6	2.3	3.8	2.7	2.9
Fuel-C	1.6	0.6	0.8	1.0	1.0
					4.3

with Cover Crops

kg - /ha	Tomato	Saff	Corn	Bean	System
ΔSoil C	-42	1578	1358	-1171	475
N2O	2.2	1.8	2.8	3.7	2.4
Fuel-C	446	172	215	200	258

tCO2e	Tomato	Saff	Corn	Bean	System
Soil C	0.2	-5.6	-5.0	4.3	1.6
N2O	2.0	1.6	2.6	2.5	2.2
Fuel-C	1.5	0.6	0.8	0.7	0.9
					1.6

Five Points, Fresno County

	Standard Tillage						Reduced Tillage					
	Conventional			with Cover Crop			Conventional			with Cover Crop		
kg - /ha	Tomato	Cotton	System	Tomato	Cotton	System	Tomato	Cotton	System	Tomato	Cotton	System
Δ Soil C			97			714			95			1427
N2O	5.2	5.0	5.1	4.4	4.1	4.3	4.3	4.0	4.1	3.1	3.2	3.1
Fuel-C	171	138	155	232	155	194	81	68	75	92	74	83

tCO2e	Tomato	Cotton	System	Tomato	Cotton	System	Tomato	Cotton	System	Tomato	Cotton	System
Soil C			-0.1			-2.6			-0.3			-5.3
N2O	4.9	4.6	4.7	4.1	3.8	4.0	4.0	3.7	3.9	2.9	2.9	2.9
Fuel-C	0.6	0.5	0.6	0.9	0.6	0.7	0.3	0.2	0.3	0.3	0.3	0.3
			5.2			2.1			3.8			-2.1

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