DAYCENT Agro-ecosystem Model

W.J. Parton, S.J. Del Grosso, D.S. Ojima, B. McCarl

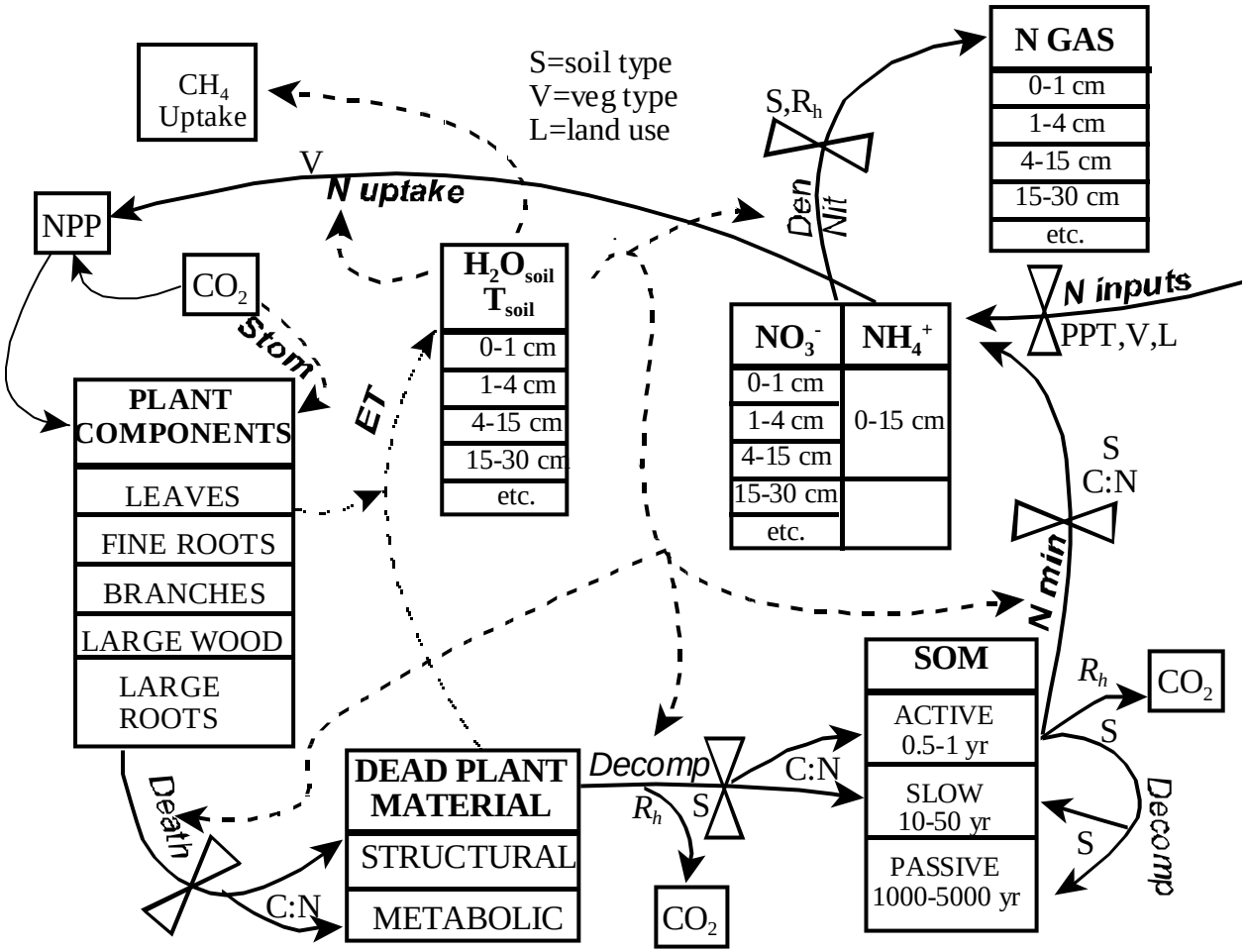
OUTLINE

1. Model Description

2. Model Testing

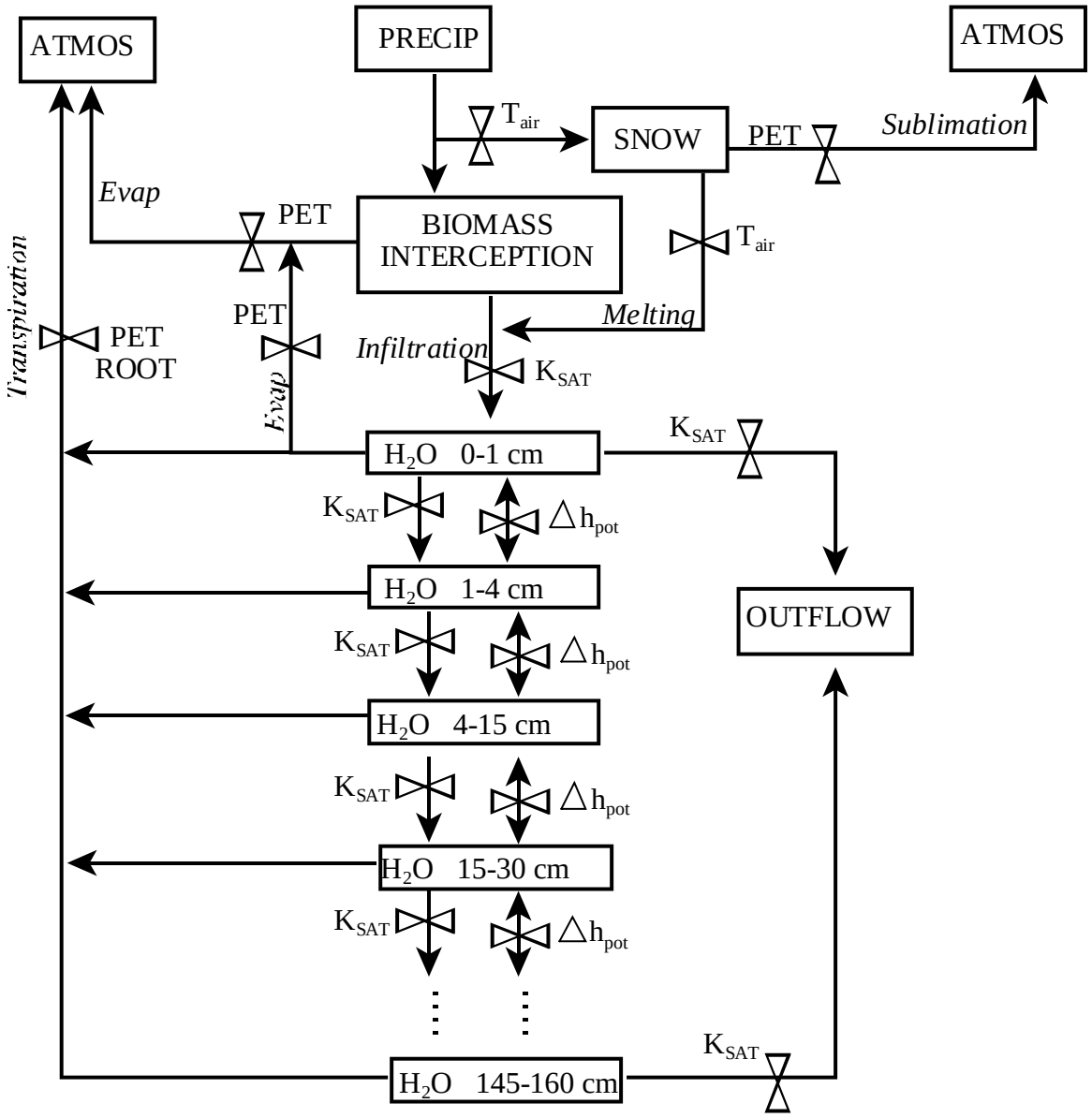
3. Model Applications
   a. Net Greenhouse Gas Assessment
   b. Economic Analysis

DAYCENT MODEL

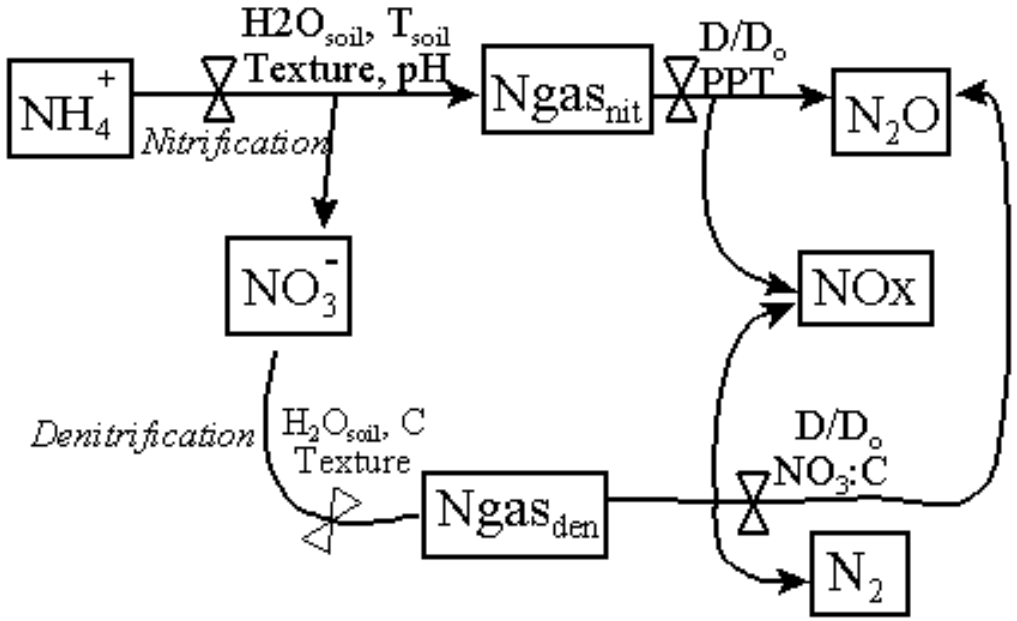


Parton et al. 1998
Kelly et al. 2000
Del Grosso et al. 2001

WATER FLOW SUBMODEL

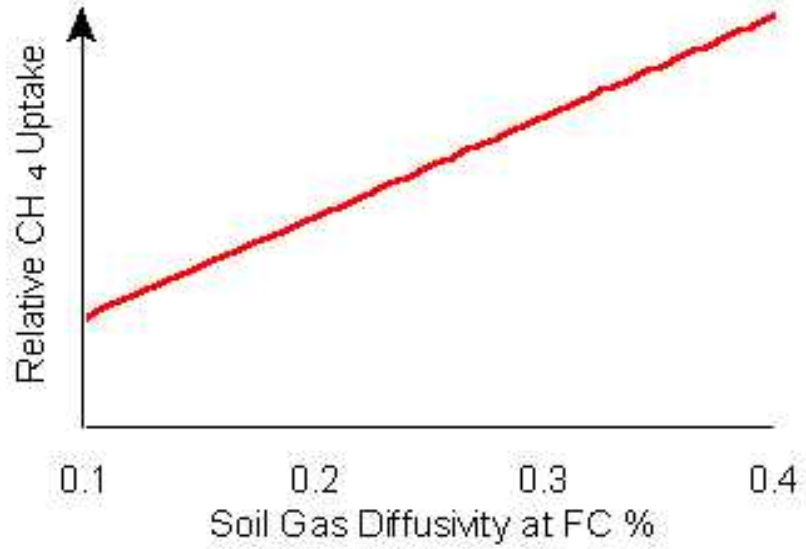


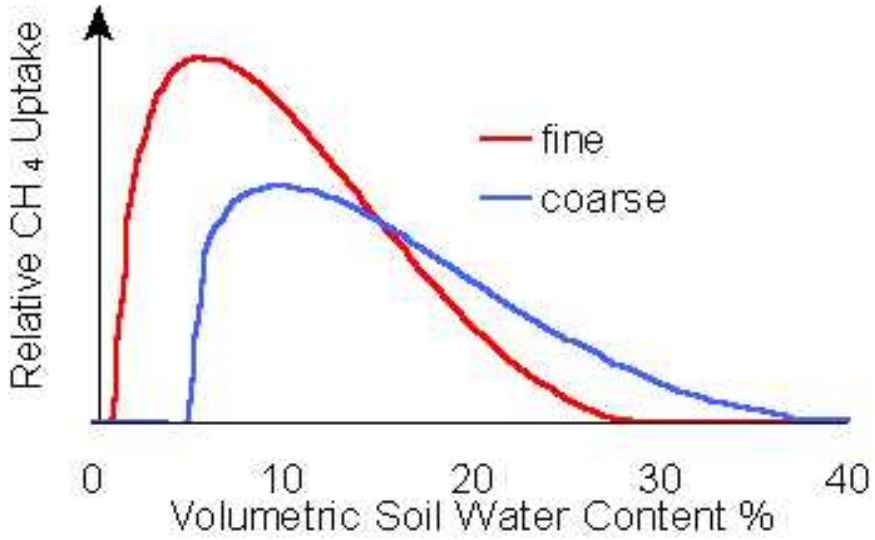
N Gas Submodel



Ngas$_{nit}$ = N gas flux from nitrification
Ngas$_{den}$ = N gas flux from denitrification
D/D$_o$ = index of gas diffusivity in soil
PPT = precipitation
C = labile carbon

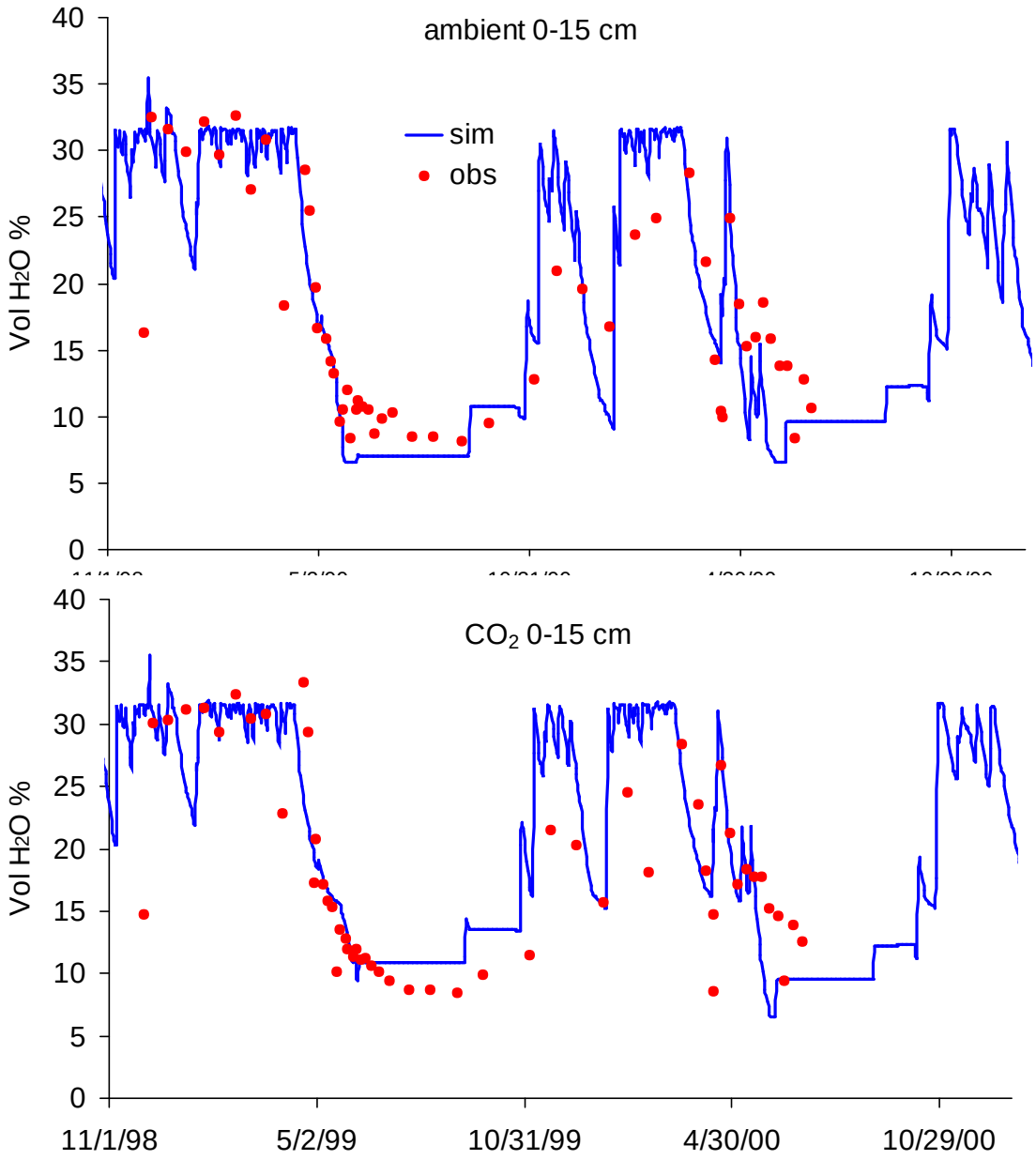
$$CH_4 = F(D_o, H_2O, Temp)$$



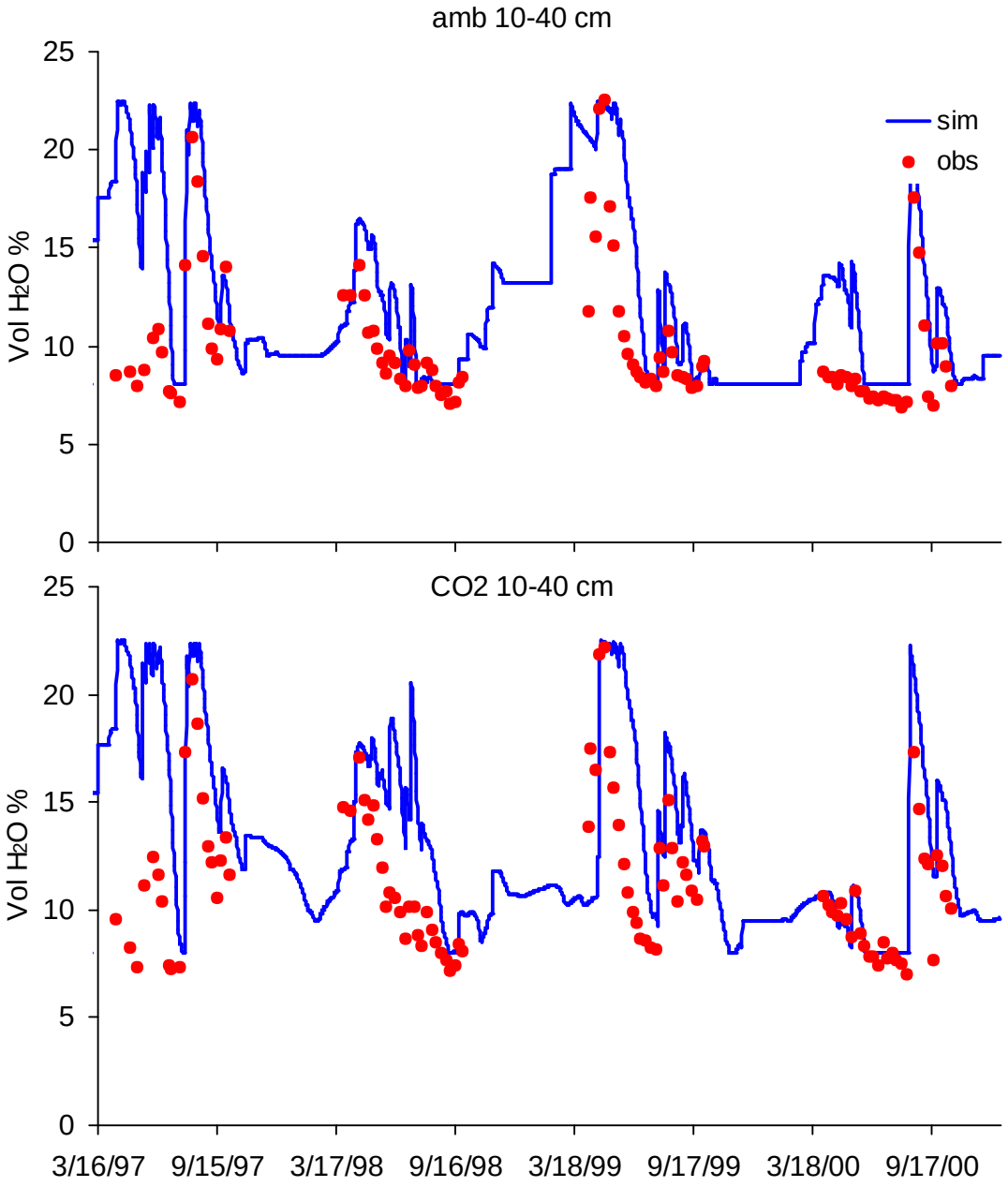


Del Grosso et al. 2000

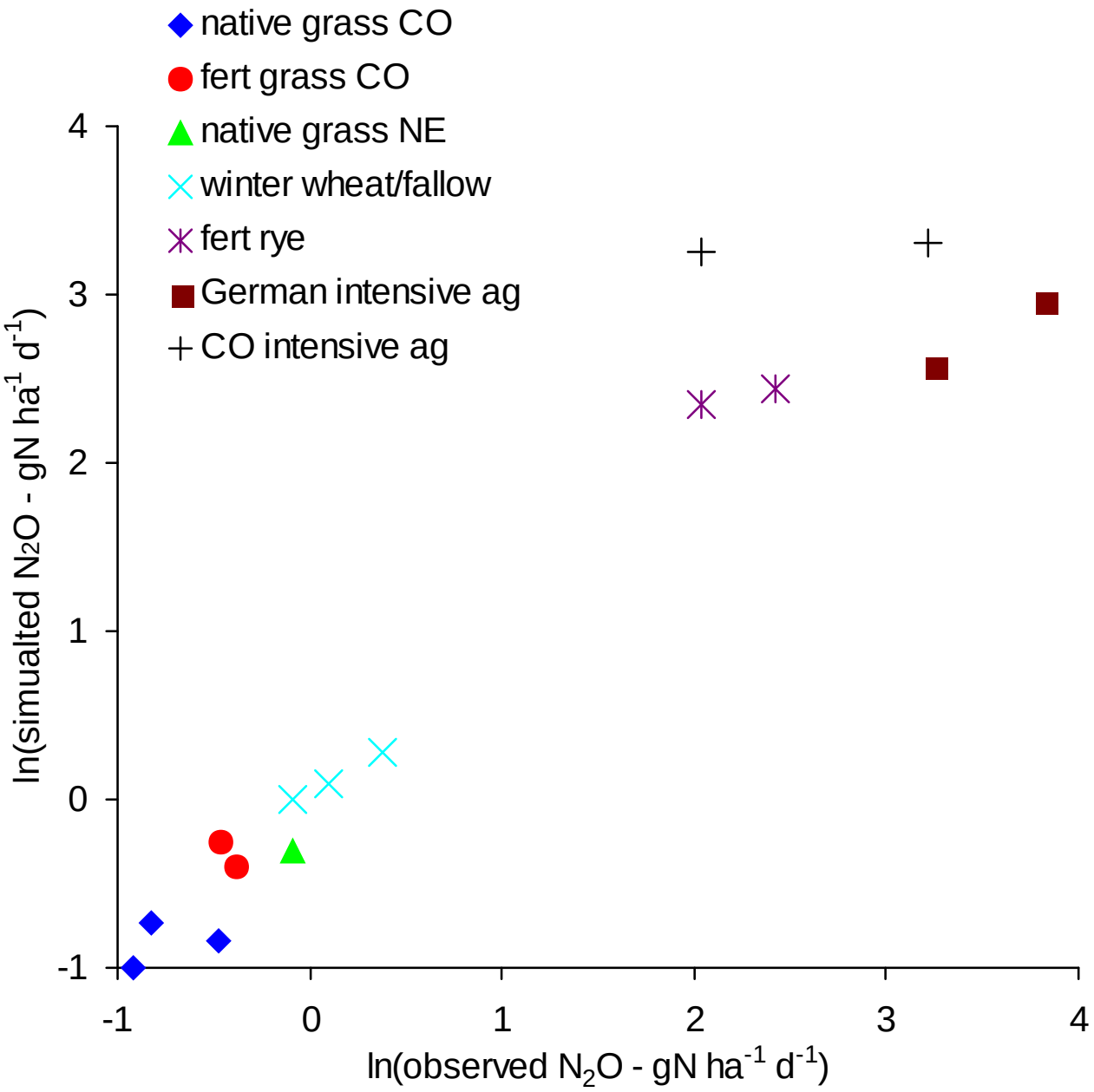
Soil H_2O Validations: Jasper Ridge Annual Grassland

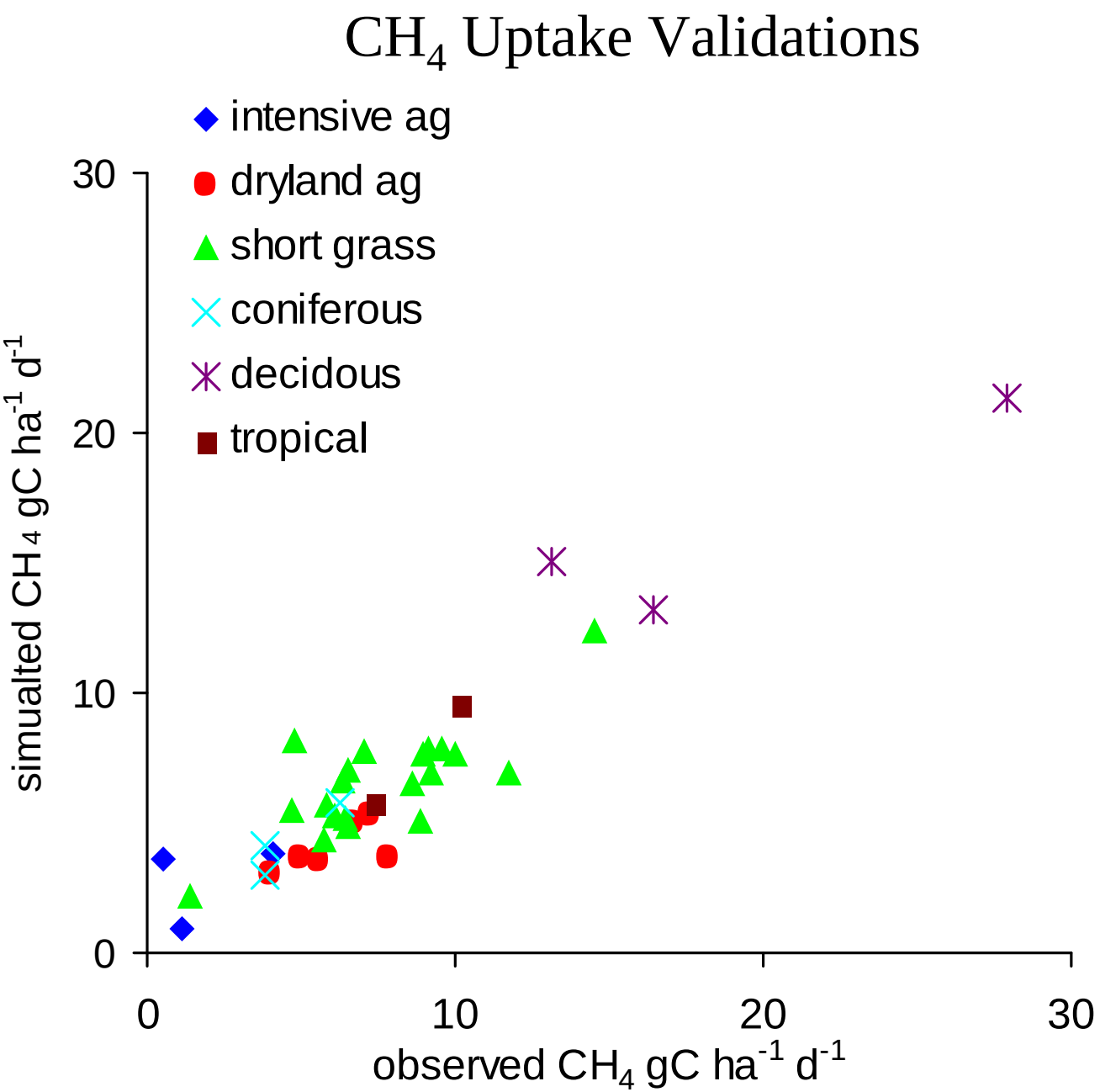


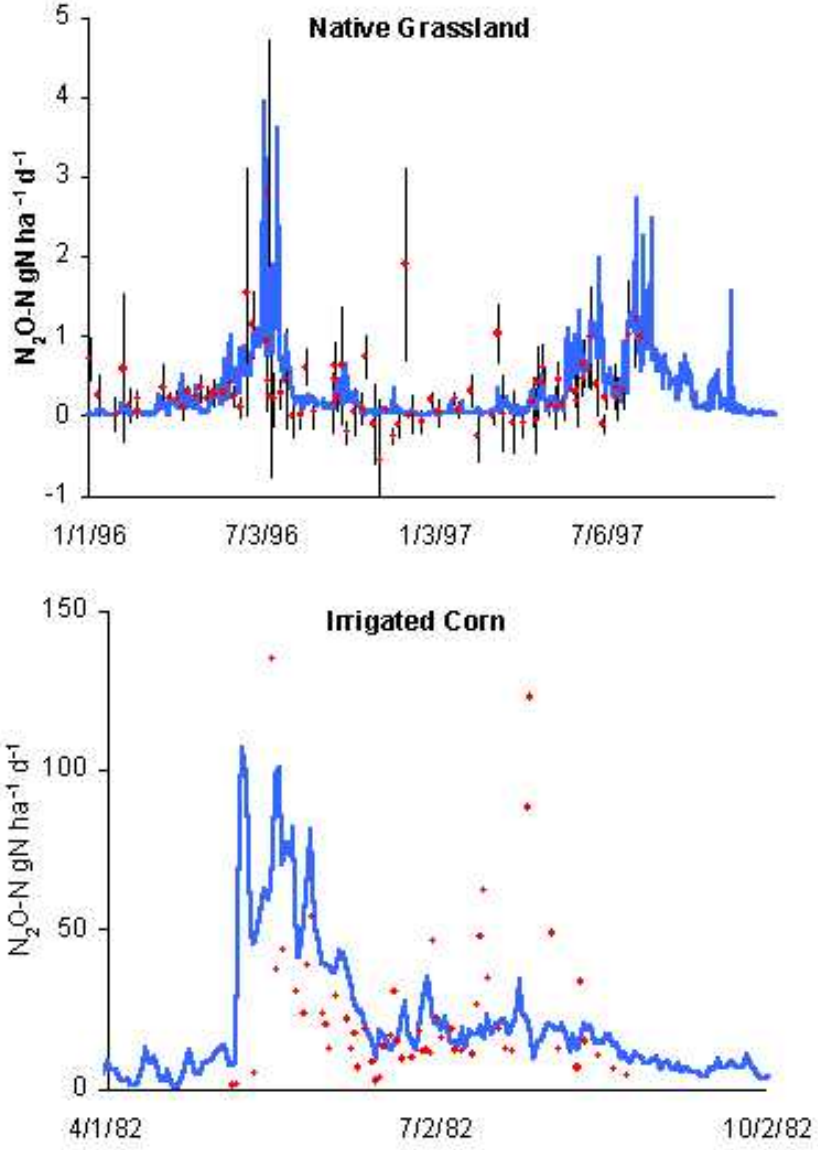
Soil H_2O Validations: Shortgrass Steppe

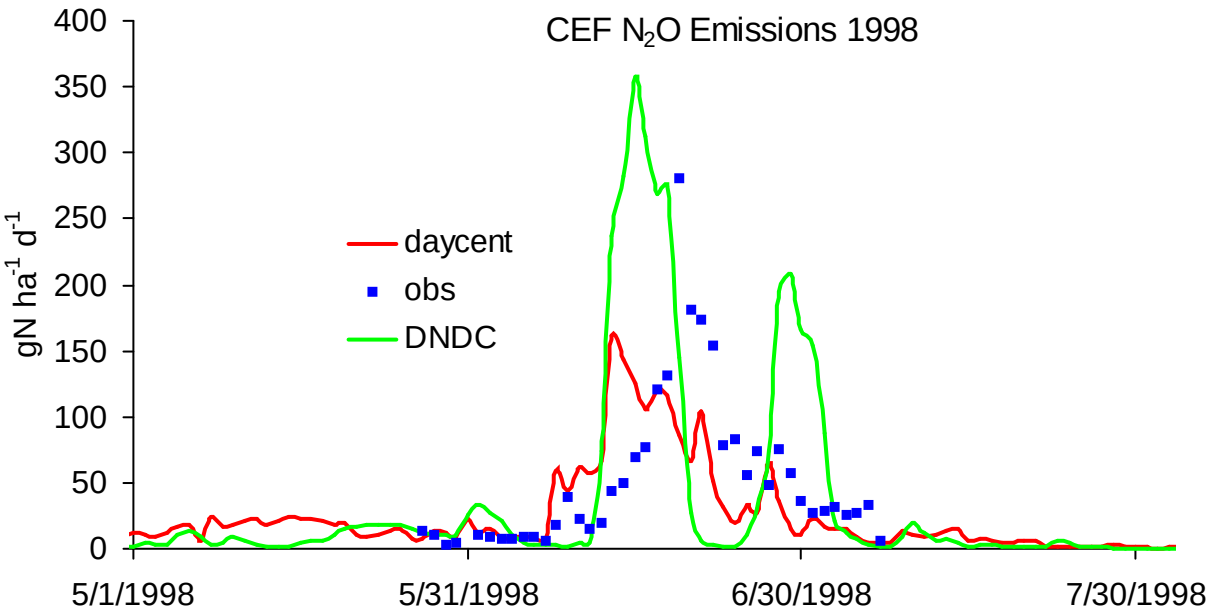


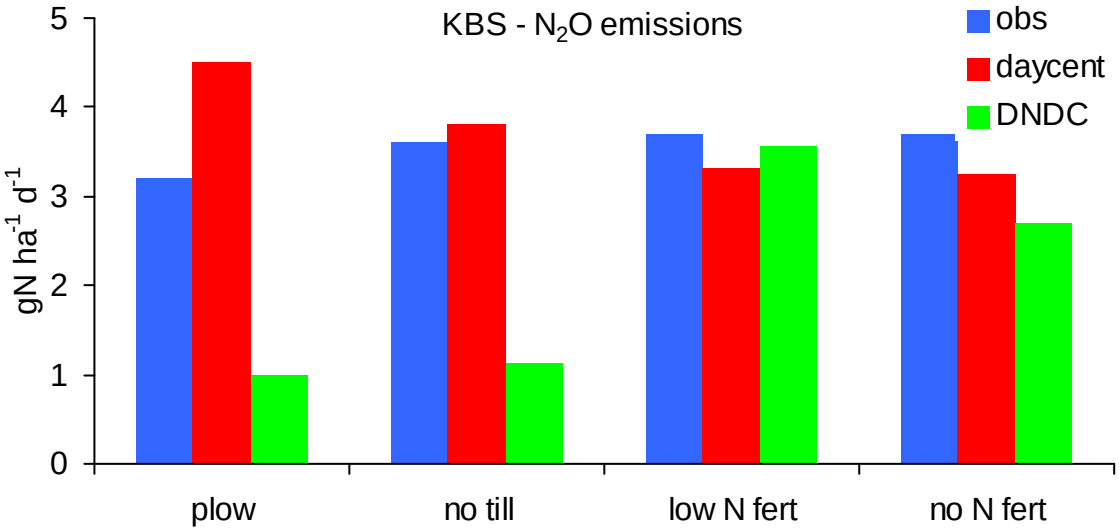
N_2O Emission Validations

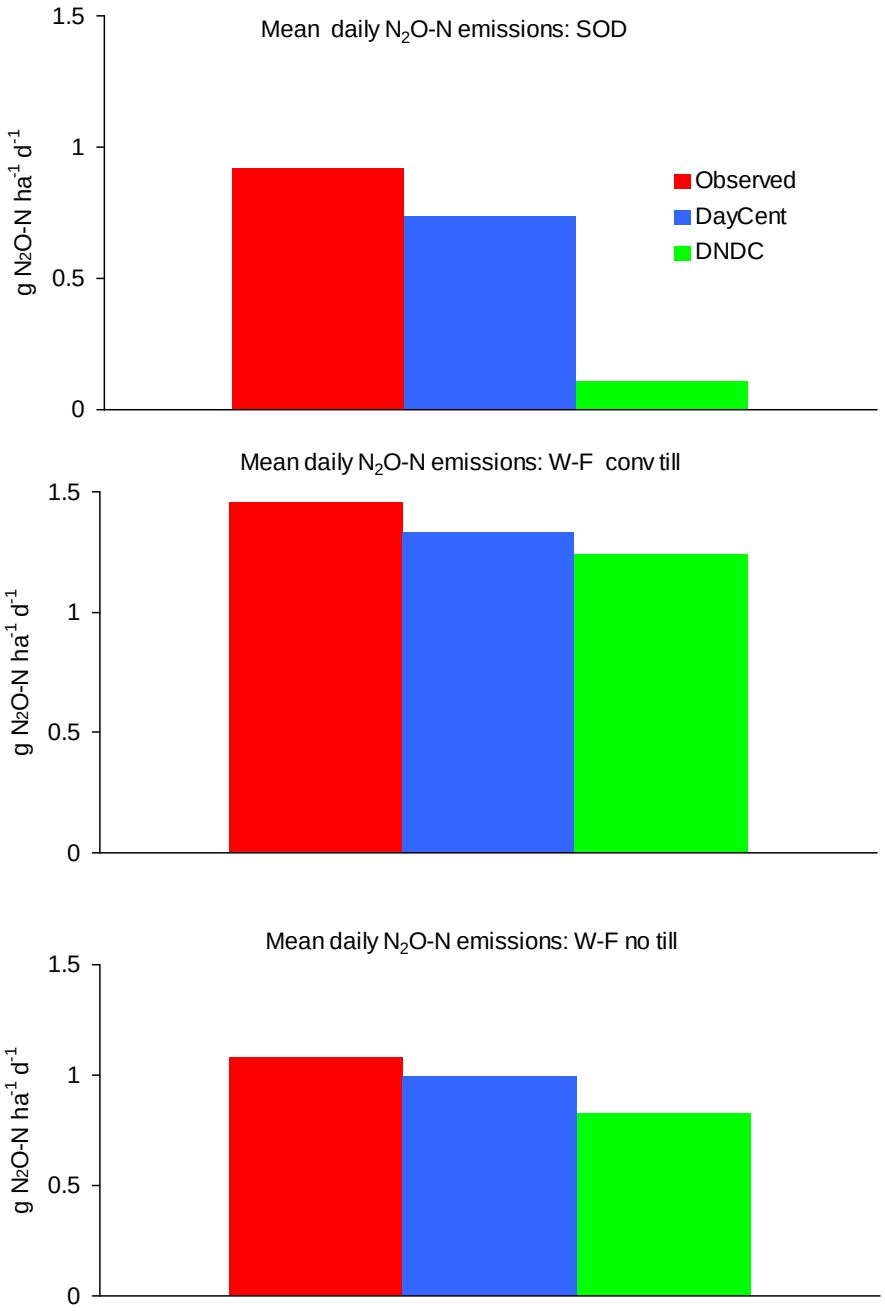


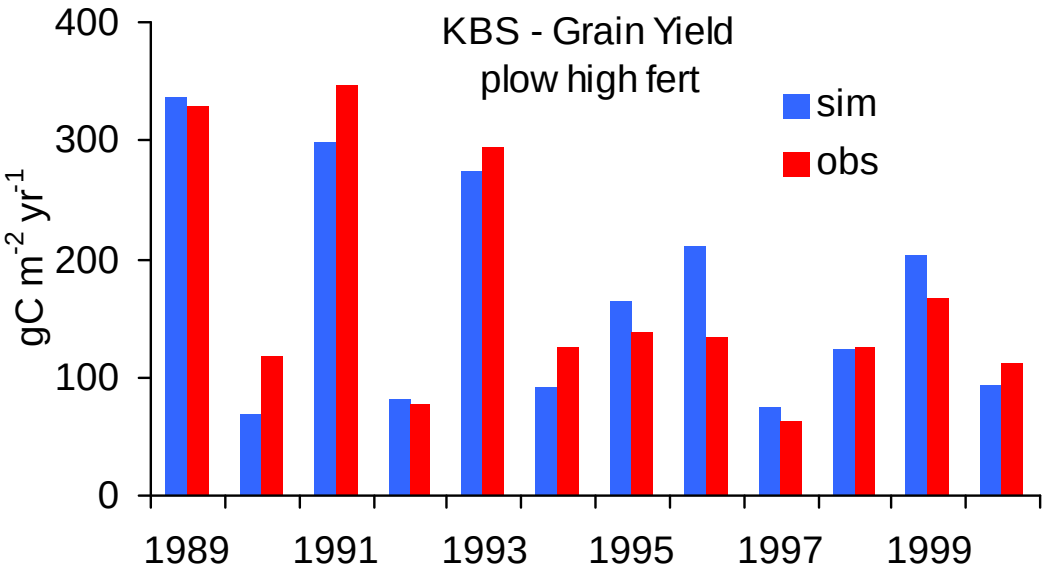

CH4 Uptake Validations
intensive ag
dryland ag
short grass
coniferous
decidous
tropical
simualted CH4 gC ha-1 d-1
observed CH4 gC ha-1 d-1
0
10
20
30

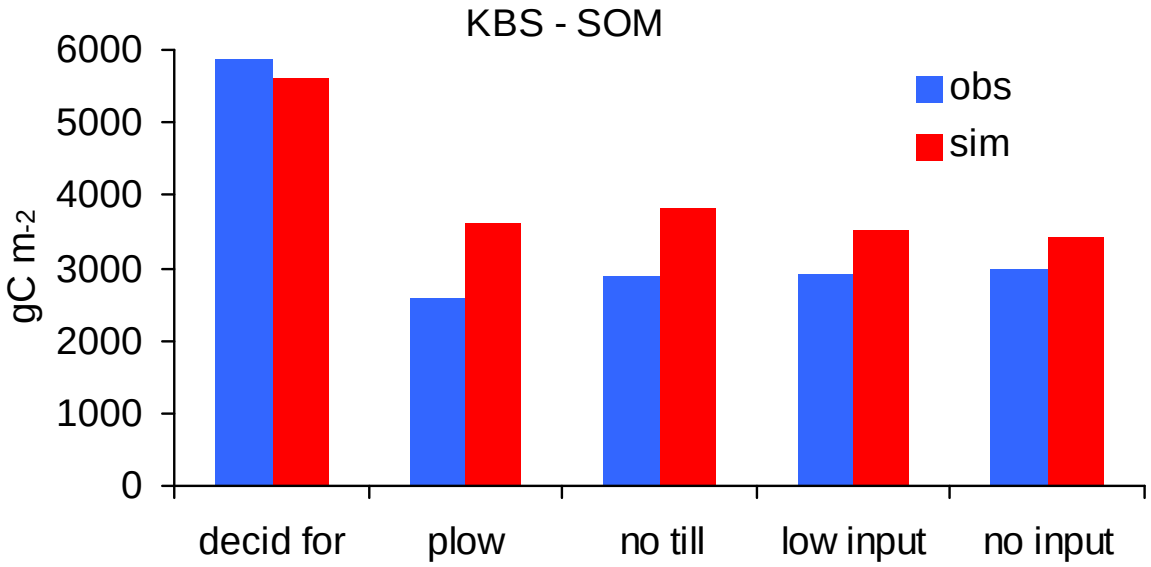

Native Grassland
N_2O-N gN ha^{-1} d^{-1}
5
4
3
2
1
0
-1
1/1/96
7/3/96
1/3/97
7/6/97
Irrigated Corn
N_2O-N gN ha^{-1} d^{-1}
150
100
50
0
4/1/82
7/2/82
10/2/82


CEF N_2O Emissions 1998
gN ha^{-1} d^{-1}
400
350
300
250
200
150
100
50
0
daycent
obs
DNDC
5/1/1998
5/31/1998
6/30/1998
7/30/1998

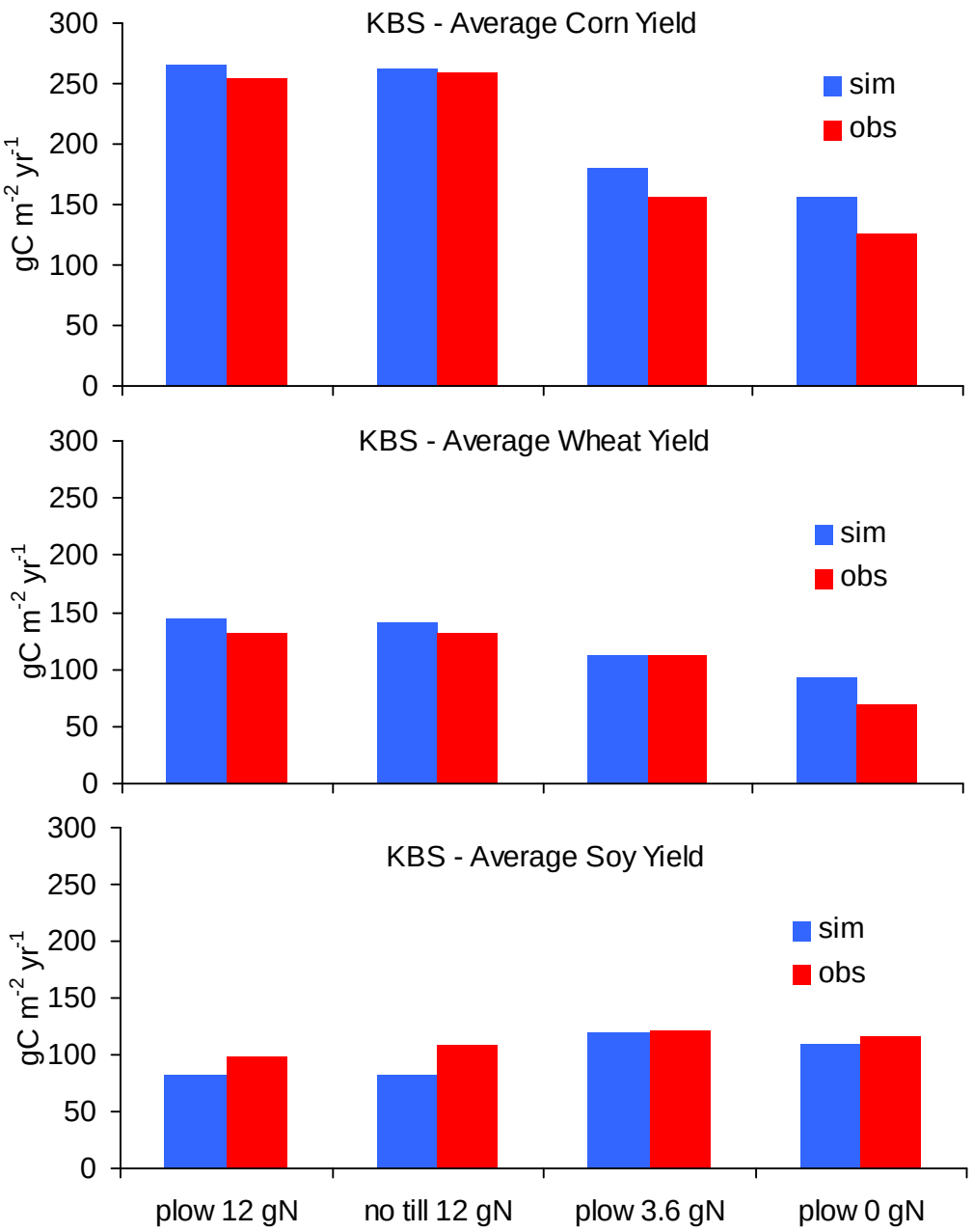

KBS - N_2O emissions
gN ha^{-1} d^{-1}
5
4
3
2
1
0
obs
daycent
DNDC
plow
no till
low N fert
no N fert


Mean daily N2O-N emissions: SOD
g N2O-N ha-1 d-1
1.5
1
0.5
0
Observed
DayCent
DNDC
Mean daily N2O-N emissions: W-F conv till
g N2O-N ha-1 d-1
1.5
1
0.5
0
Mean daily N2O-N emissions: W-F no till
g N2O-N ha-1 d-1
1.5
1
0.5
0

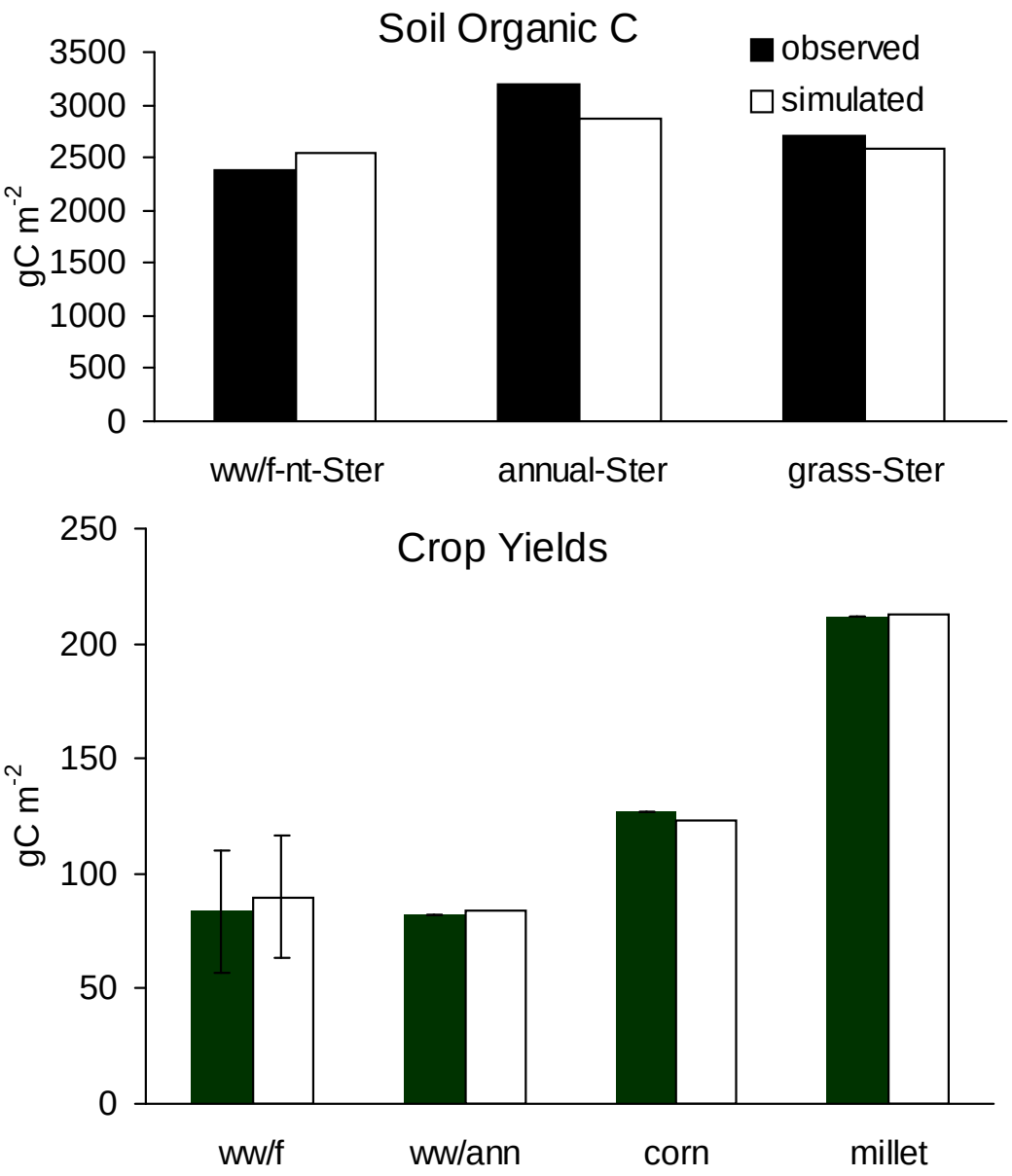

KBS - Grain Yield
plow high fert
sim
obs
gC m-2 yr-1
400
300
200
100
0
1989
1991
1993
1995
1997
1999


KBS - SOM
obs
sim
gC m-2
6000
5000
4000
3000
2000
1000
0
decid for
plow
no till
low input
no input

Model Validations: Kellogg Biological Station



Model Validations: Sterling Colorado



Land Use Scenarios Simulated by DAYCENT for US Great Plains

Business as Usual			Improved Management		
Crop Rotation	Fertilizer kgN ha^{-1} yr^{-1}	Tillage	Crop Rotation	Fertilizer KgN ha^{-1} yr^{-1}	Tillage
Winter wheat/ fallow	38.5	Conventional	Winter wheat/ fallow/corn (dry)	55	No Till
Corn (irrigated)	100	Conventional	Corn (irrigated)	100	No Till
Winter wheat continuous	80	Conventional	Winter wheat/ soy/corn	63	No Till

Net GHG Flux Calculation

$GHG_{net} = DSOC + C_{N2O} + C_{CH4} + C_{nfert}$

DSOC integrates CO_2 fixation and respiration

C_{N2O} = CO_2-C equivalents of N_2O (GWP=311)

C_{CH4} = CO_2-C equivalents of CH_4 (GWP=25)

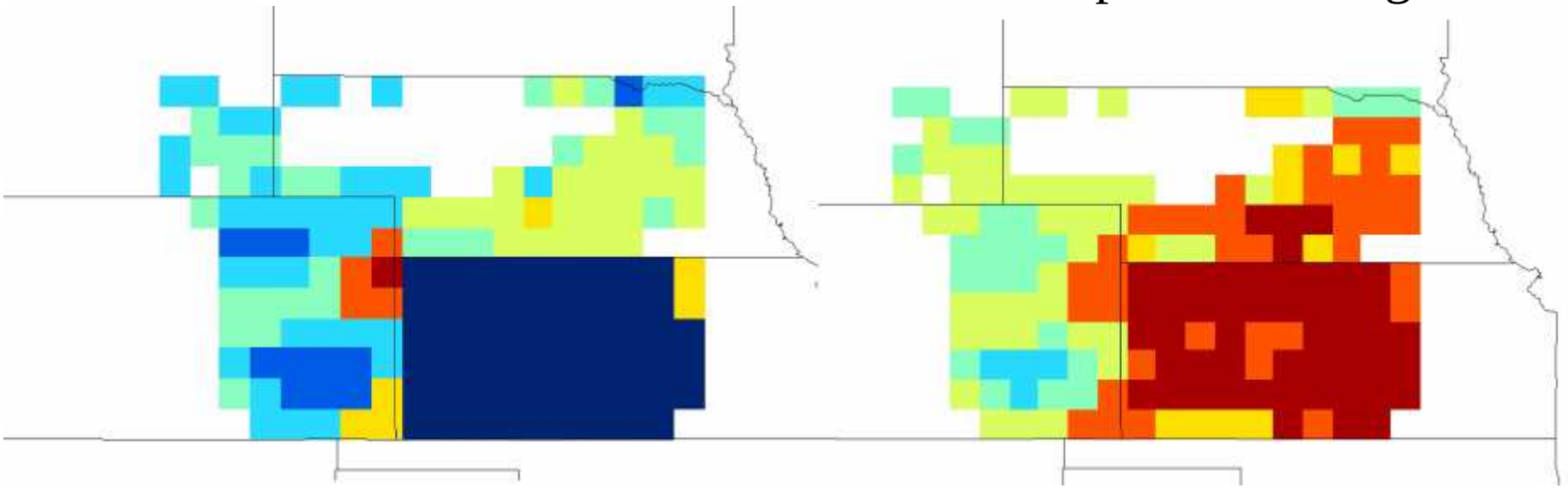
C_{Nfert} = CO_2-C equivalents of N fert prod (0.8 gCO_2-C /1.0 gN)

$$GHG_{net} = DC_{soil} + C_{N20} + C_{CH4} + C_{FERT}$$

(1st 12 year interval)

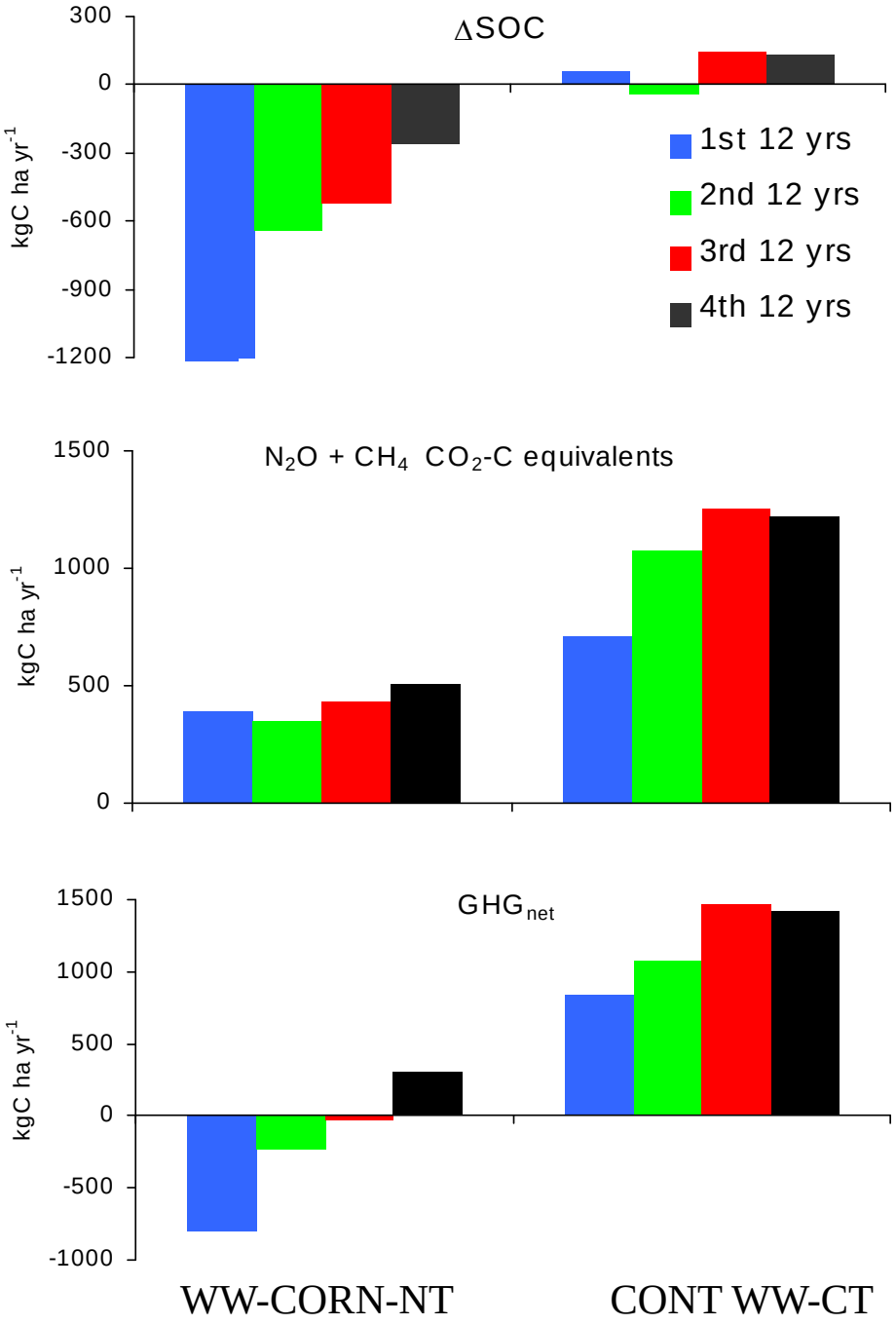
Business as Usual

Improved Management

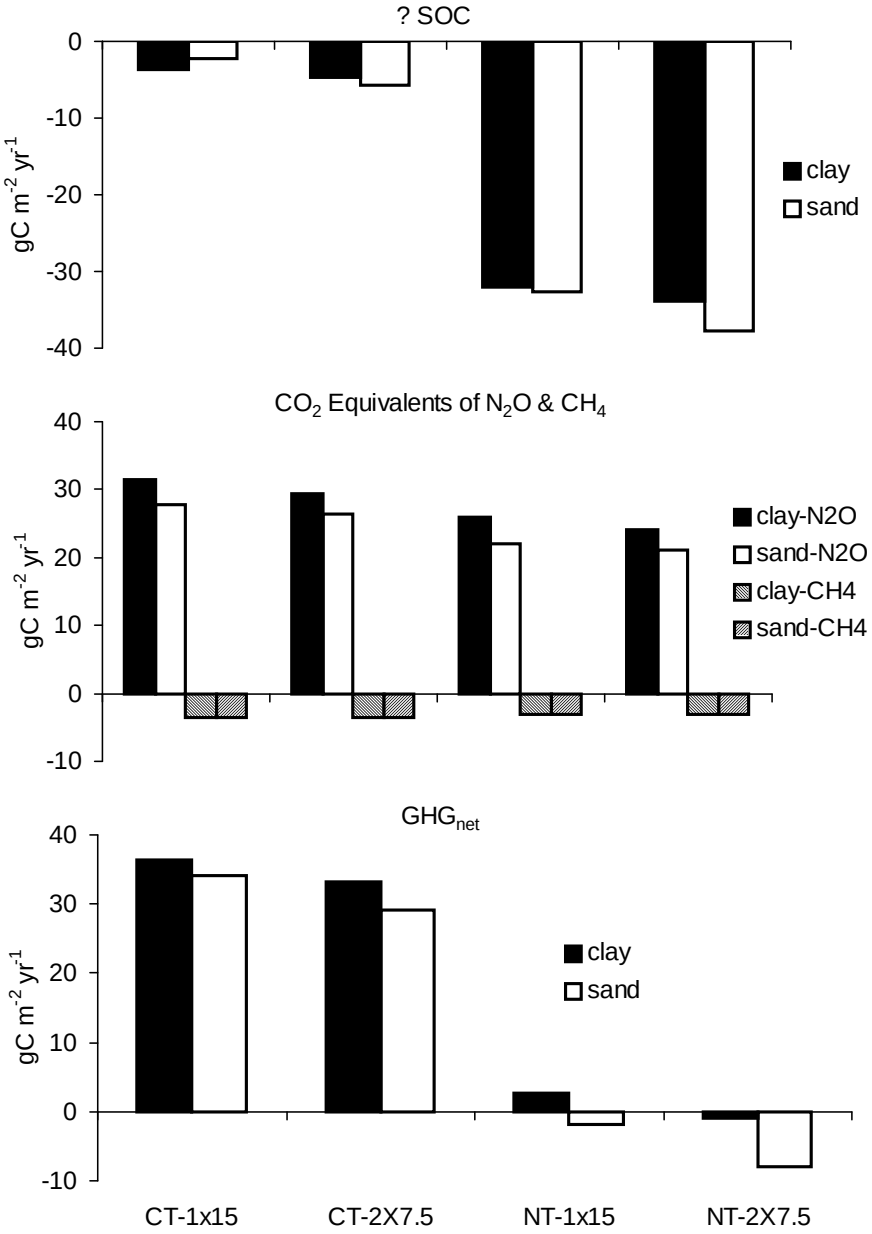


KgC ha^{-1} yr^{-1}

-700	-99 - 100
-699 - -500	101 - 300
-499 - -300	301 - 500
-299 - -100	501 - 700


ΔSOC
300
0
-300
-600
-900
-1200
kgC ha yr-1
1st 12 yrs
2nd 12 yrs
3rd 12 yrs
4th 12 yrs
N2O + CH4 CO2-C equivalents
1500
1000
500
0
kgC ha yr-1
GHGnet
1500
1000
500
0
-500
-1000
kgC ha yr-1
WW-CORN-NT
CONT WW-CT

Corn Belt: delta SOC



CT 1x15 CT 2X7.5 NT 1X15 NT 2X7.5

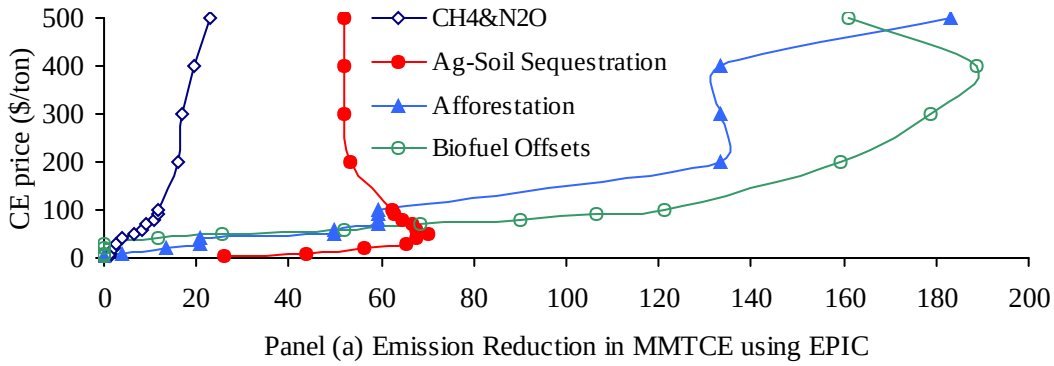
Integrating ASMGHG and CENTURY

An attempt was made to improve the representation of ASMGHG soil carbon using data from CENTURY.

A national set of per acre agricultural soil sequestration rates were developed for 63 locations, 3 tillage systems, 5 fertilization regimes, 8 crops and irrigated/dryland practices.

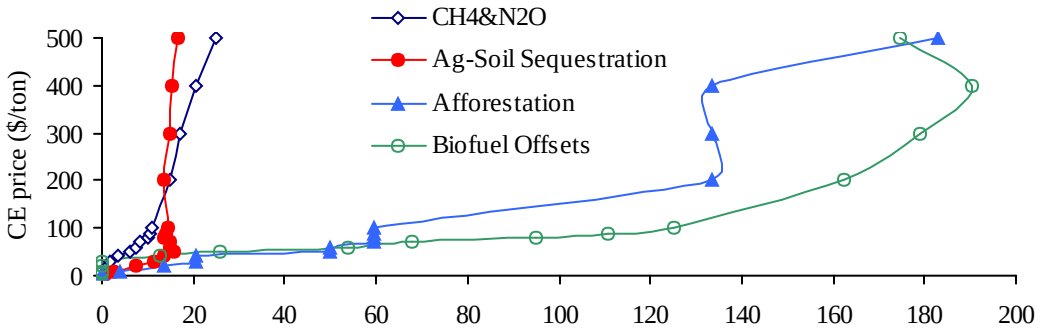
This was run by NREL personnel using CENTURY.

Before Century



Panel (a) Emission Reduction in MMTCE using EPIC

With Century Variant 1



Panel (b) Emission Reduction in MMTCE using CENTURY

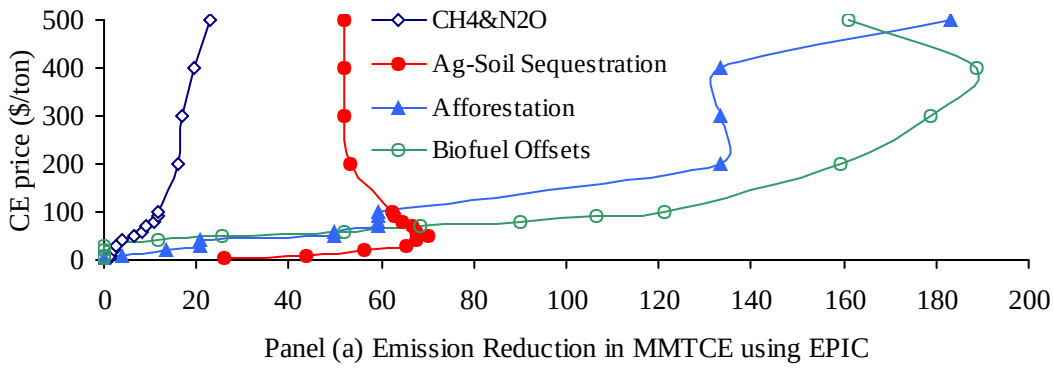
Where did the soil carbon go?

No number approached 0.25 tons/acre average from West

So? 20cm argument 2x still low

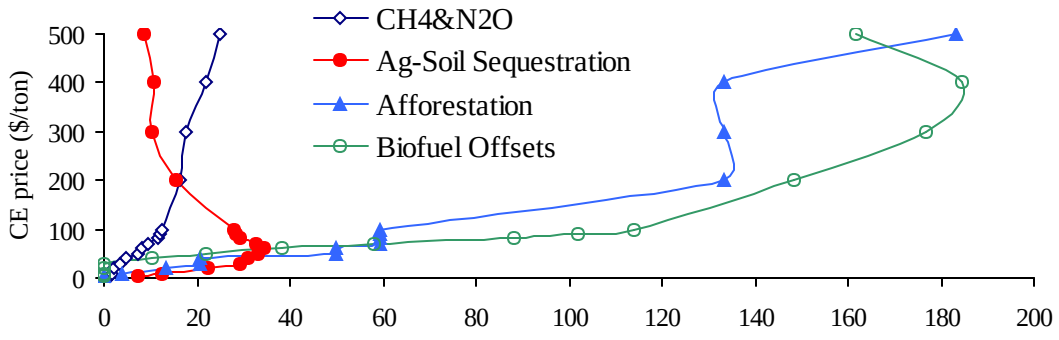
30-15 years 4x

Before Century



Panel (a) Emission Reduction in MMTCE using EPIC

With Century
Variant 1



(c) Emission Reduction in MMTCE using CENTURY multiplied by 4

Missing adjustment factor
3 Centuries
Watch out and validity test 2x
Bill Parton and DAYCENT
Time to saturation? Adjustment for 20cm?

Conclusions:

1. DAYCENT has been well tested using SOC, grain yield, N_2O, and CH_4 data sets

2. DAYCENT has been used for full greenhouse gas impact assessments

3. Results are being incorporated into economic assessment models