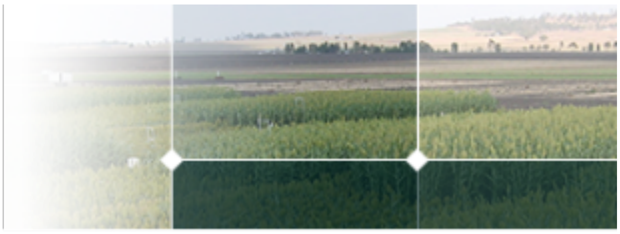


1 Nutrient

The soil nutrient model includes functionality for simulating pools of organic matter and mineral nitrogen. The processes for each are described below.

1.1 Structure

Soil organic matter is modelled as a series of discrete organic matter pools which are described in terms of their masses of carbon and nutrients. These pools are initialised according to approaches specific to each pool. Organic matter pools may have carbon flows, such as a decomposition process, associated to them. These carbon flows are also specific to each pool, are independently specified, and are described in each case in the documentation for each organic matter pool below.

Mineral nutrient pools (e.g. Nitrate, Ammonium, Urea) are described as solutes within the model. Each pool captures the mass of the nutrient (e.g. N,P) and they may also contain nutrient flows to describe losses or transformations for that particular compound (e.g. denitrification of nitrate, hydrolysis of urea).

1.2 Pools

A nutrient pool class is used to encapsulate the carbon and nitrogen within each soil organic matter pool. Child functions within these classes provide information for initialisation and flows of C and N to other pools, or losses from the system.

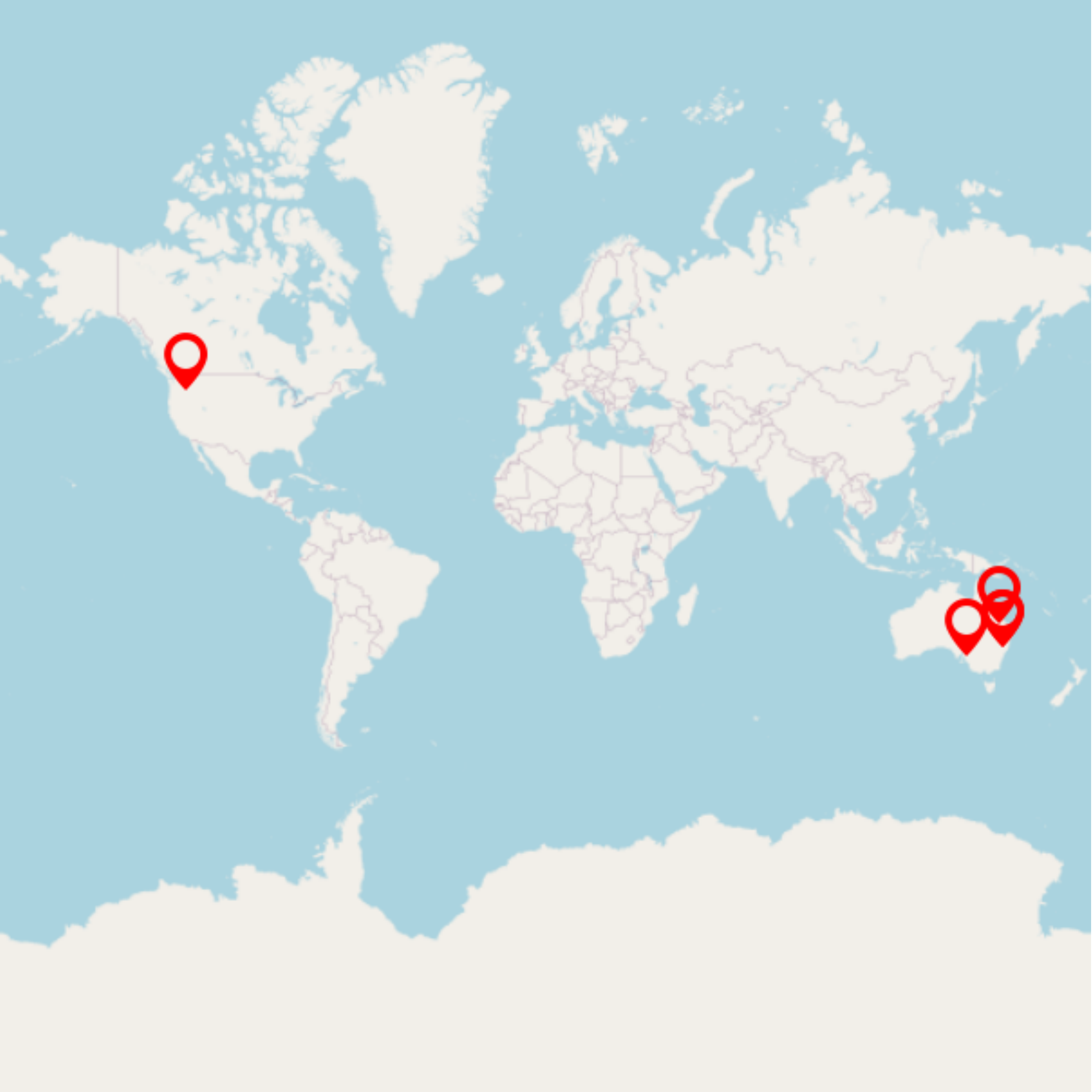
The soil organic matter pools used within the model are described in the following sections in terms of their initialisation and the carbon flows occurring from them.

1.3 Solutes

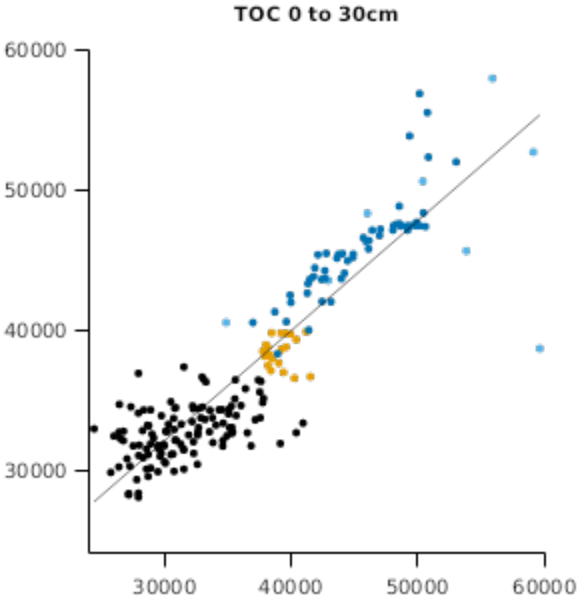
The soil mineral nutrient pools used within the model are described in the following sections in terms of their initialisation and the flows occurring from them.

2 Validation

The Soil Nutrient model has been tested on a variety of datasets studying the impact of management (tillage, cropping rotation, nitrogen management) on soil carbon, nitrogen and crop productivity for a range of soil types and environments.



2.1 Combined Results



2.2 Australia

Test data are provided for three locations across Australia, ranging from warmer subtropical Queensland, through to cooler temperature locations in southern Australia.

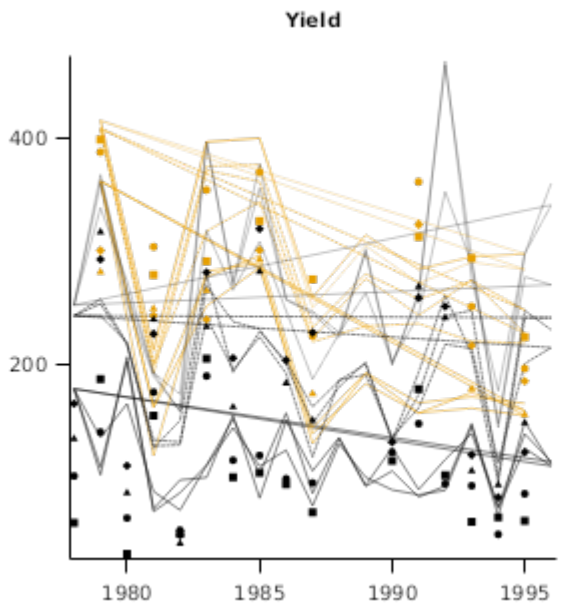
2.2.1 Tarlee

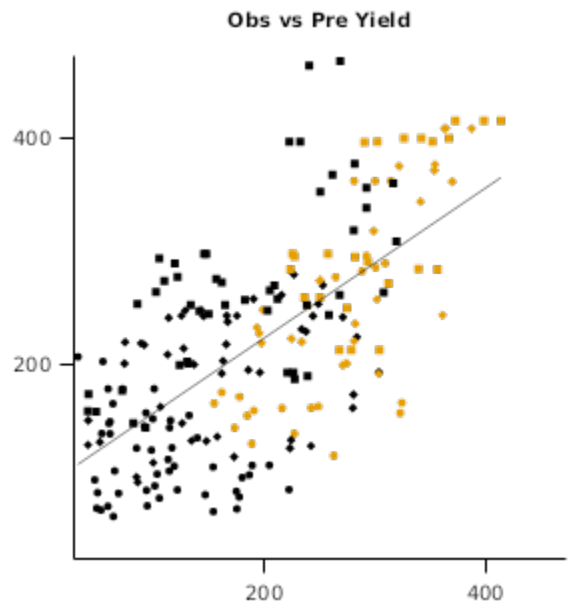
This Rotation Trial (Schultz, 1995) was located near the township of Tarlee (34.28 S, 138.77E) in South Australia from 1979 to 1996. It was established on a Red Brown Earth to monitor the long term effects of rotations on soil properties and crop production. In this test, we use data for continuous wheat, and wheat-fallow rotations with 3 stubble treatments (burning, incorporation, retention) and 3 Nitrogen rates (0,40,80 kg/ha).

List of experiments.

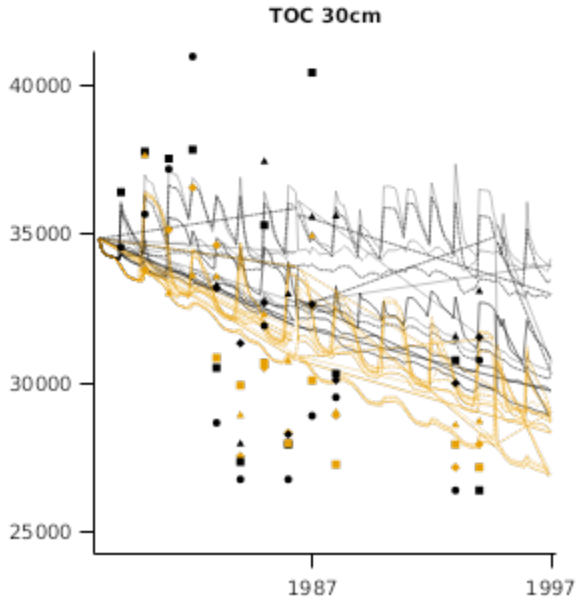
Experiment Name	Design (Number of Treatments)
Tarlee	Rotation x Stubble x N (18)

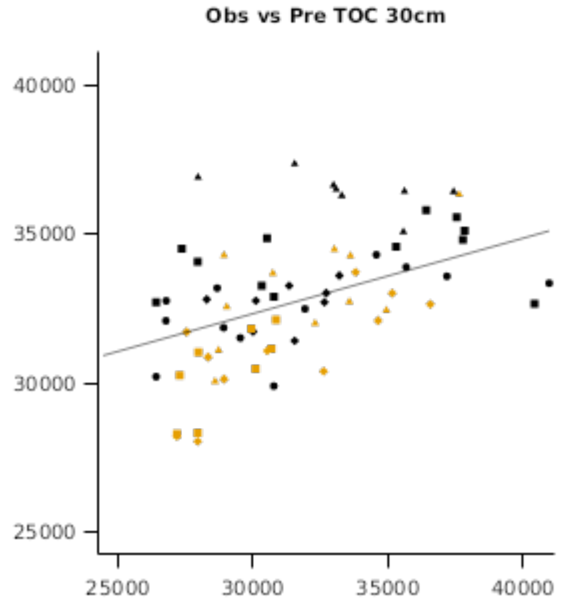
2.2.1.1 Crop

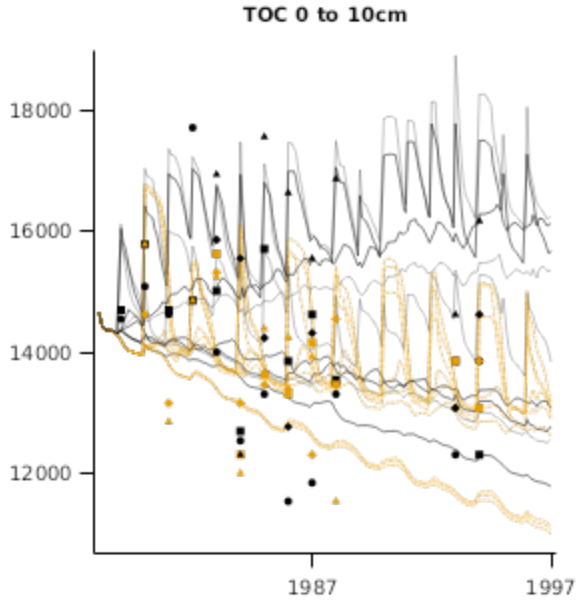


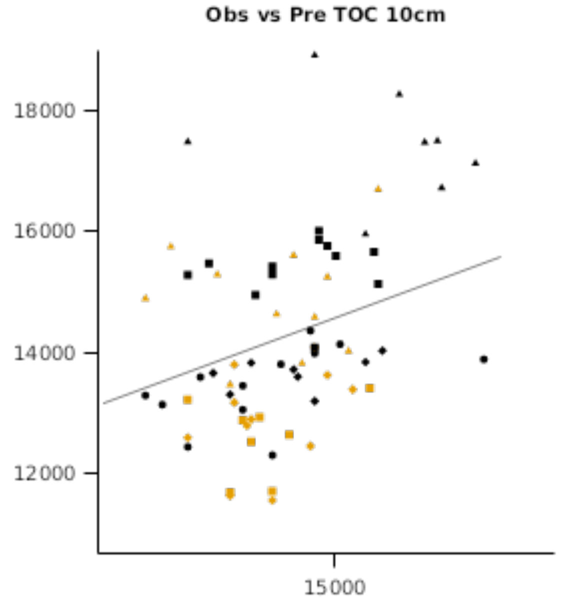


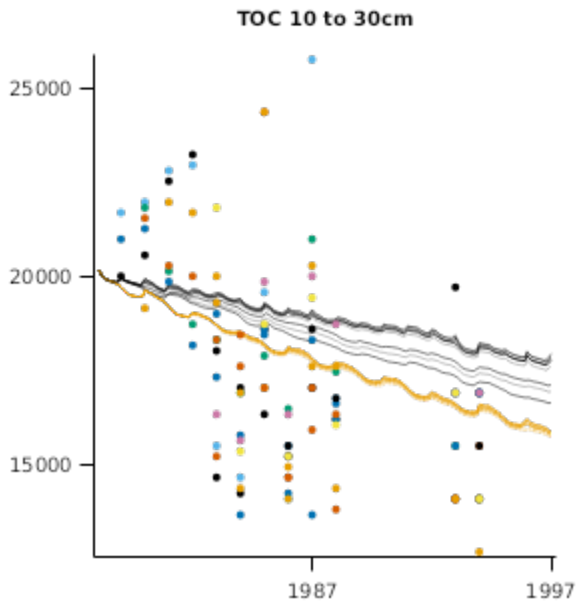
2.2.1.2 Soil

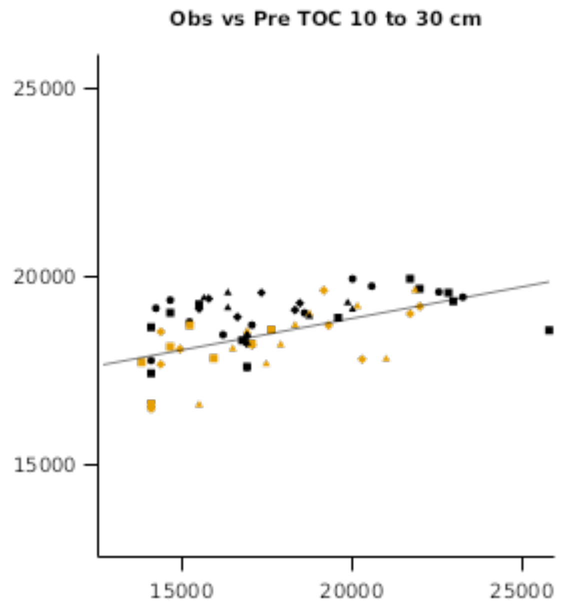

TOC 30cm
40000
35000
30000
25000
1987
1997

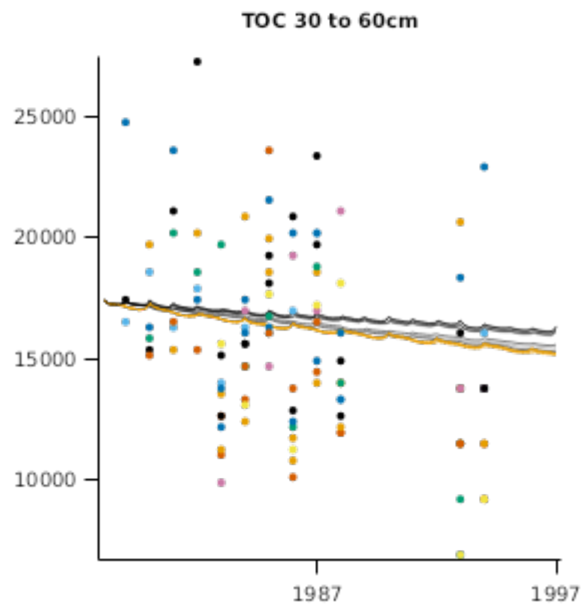

Obs vs Pre TOC 30cm
40000
35000
30000
25000
25000
30000
35000
40000

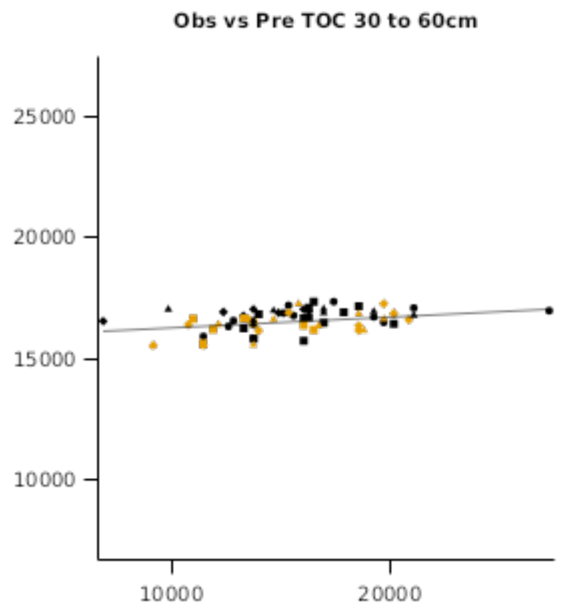

TOC 0 to 10cm
18000
16000
14000
12000
1987
1997


Obs vs Pre TOC 10cm
18000
16000
14000
12000
15000


TOC 10 to 30cm
25000
20000
15000
1987
1997


Obs vs Pre TOC 10 to 30 cm
25000
20000
15000
15000
20000
25000





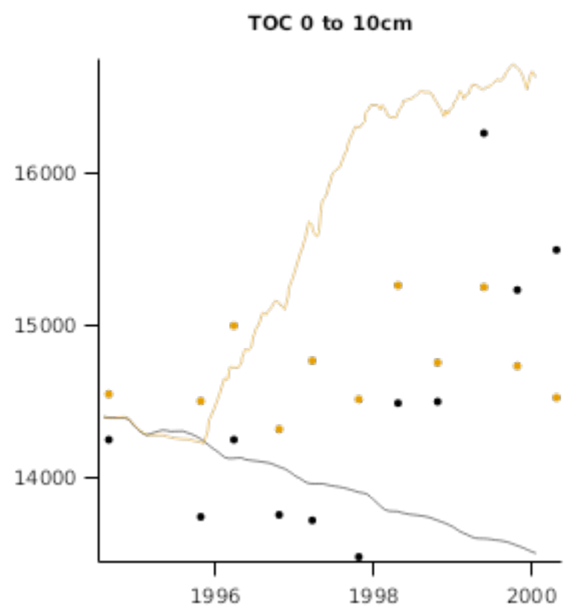
2.2.2 Hudson

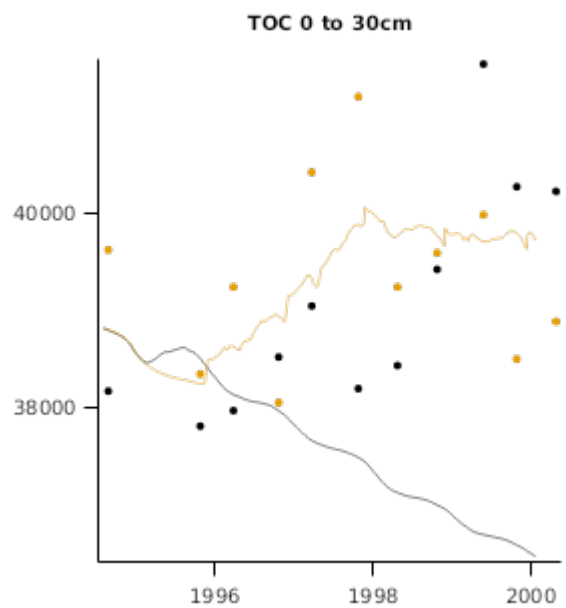
This dataset demonstrates cropping system performance and soil carbon dynamics under continuous winter cereal versus perrenial pasture. The cropping and pasture systems experiment was established in August 1994 on the farming property 'Hudson' located in the foothills of the Liverpool Ranges (31.758S, 150.458E; average annual rainfall 684mm with some summer dominance, average annual pan evaporation 1718 mm). Further details about the experiment and the data can be found at Young et al., 2009 and Paydar et al., 2005.

List of experiments.

Experiment Name	Design (Number of Treatments)
Hudson	Treatment (2)

2.2.2.1 Graphs





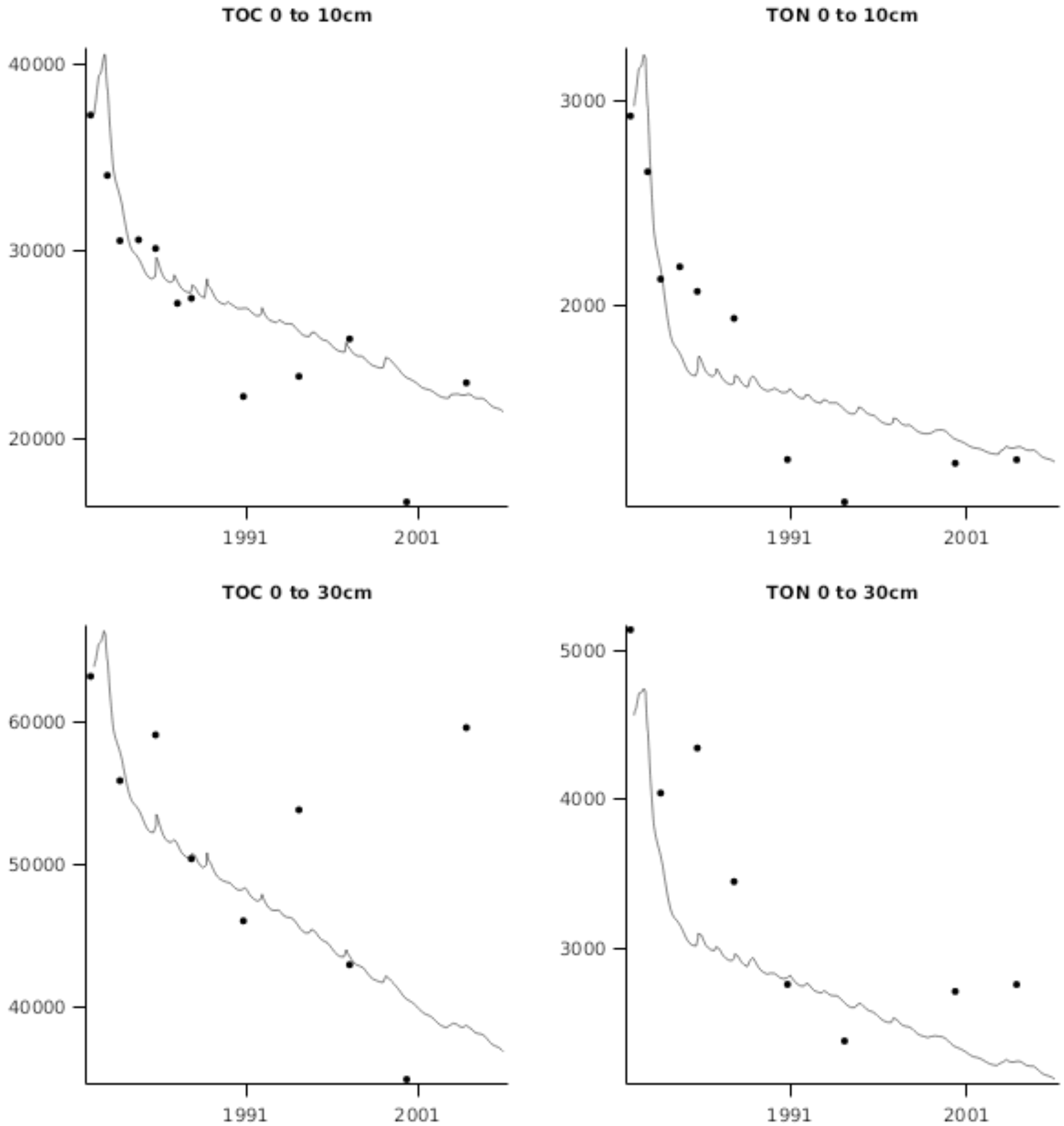
2.2.3 Brigalow Catchment Study

This dataset was originally simulated using APSIM by Huth et al., 2010. The study was conducted near Theodore, Queensland, Australia (24.81°S, 149.80°E). Several catchments were monitored under different land uses following clearing of native Brigalow Forest (Acacia Harpophylla). Data for part of the cropping catchment are used here.

List of experiments.

Experiment Name	Design (Number of Treatments)
Brigalow	Catchment (1)

2.2.3.1 Graphs



2.2.4 Horsham

List of experiments.

Experiment Name	Design (Number of Treatments)
Horsham	Treatment (3)

2.3 North America

2.3.1 Pendleton

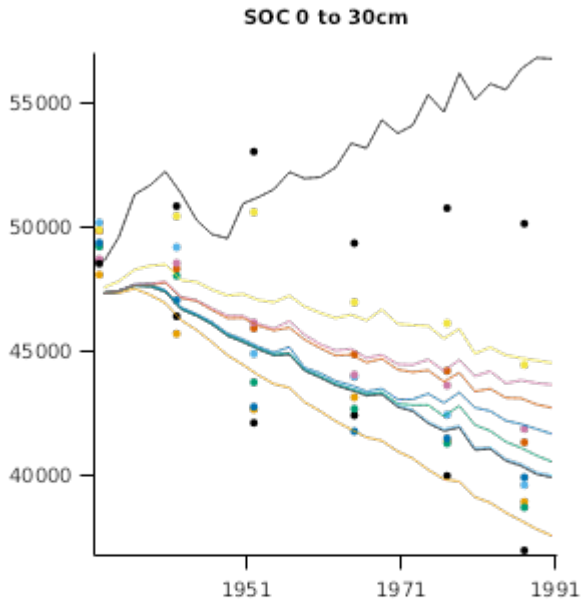
The Pendleton Long Term Experiment (Rasmussen et al., 1998) was established in 1931 at Oregon State University's Columbia Basin Agricultural Research Center near Pendleton, OR (45.72 N, 118.63 W). It consisted of nine treatments consisting of crop residue (fall burn, spring burn, and no burn) and fertility (0, 45, and 90 kg N/ha, manure, and pea vine) management practices under a Winter Wheat-Summer Fallow system. All plots were tilled using a moldboard plow, cultivated, and rod-weeded to control weeds.

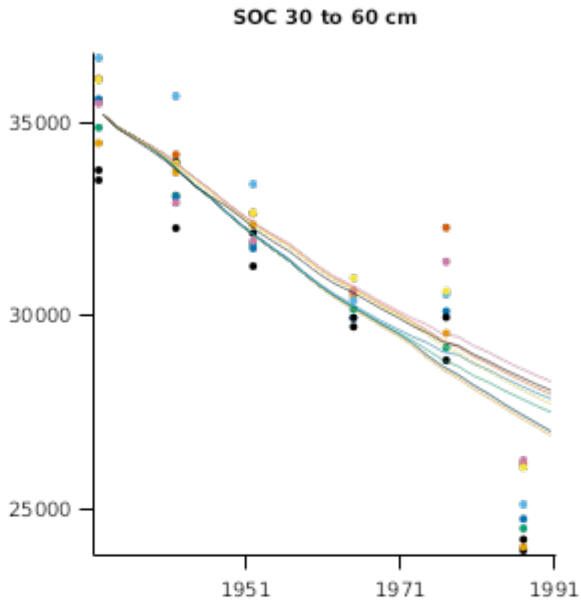
List of experiments.

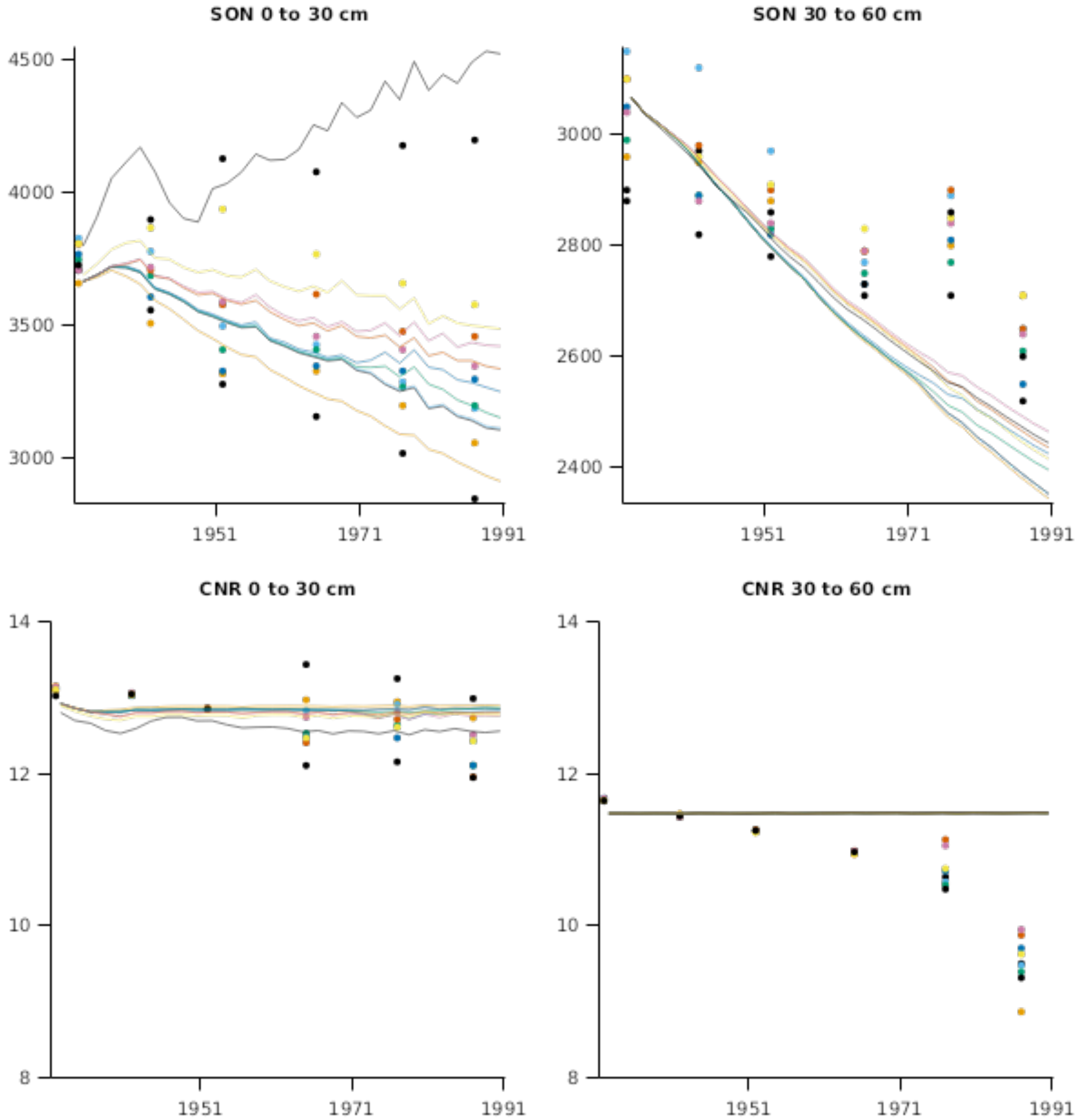
Experiment Name	Design (Number of Treatments)
Pendleton	Treatment (9)

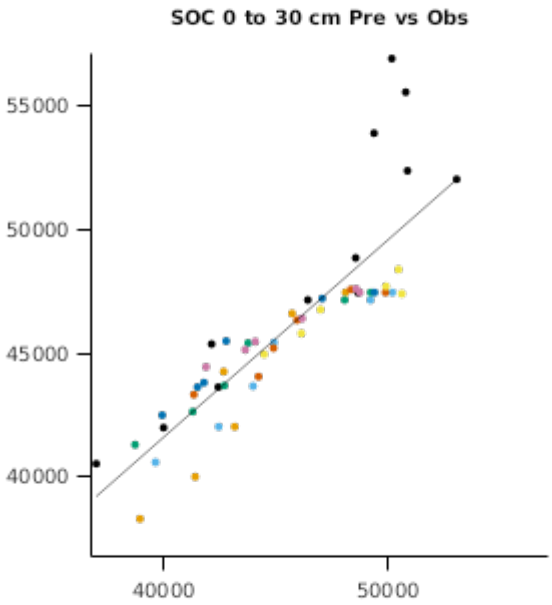
2.3.1.1 Pendleton

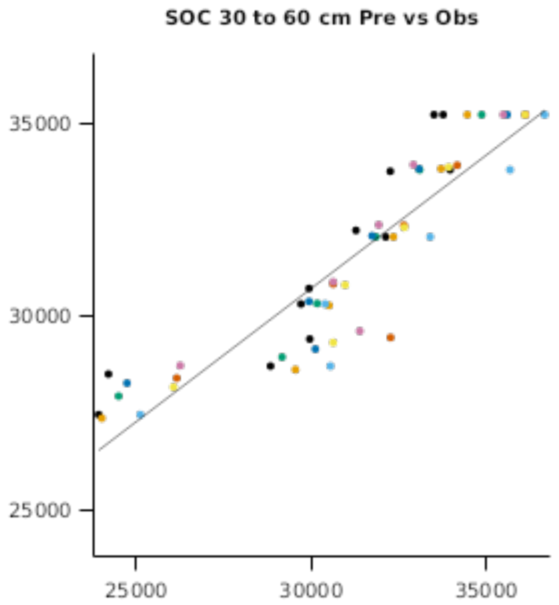
2.3.1.1.1 Soil

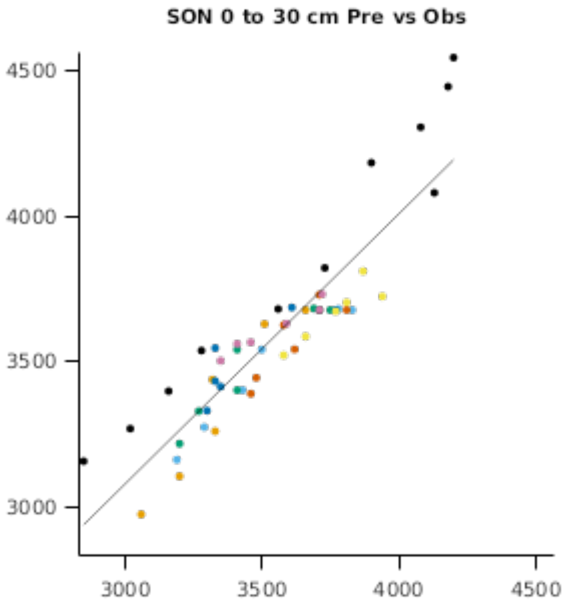


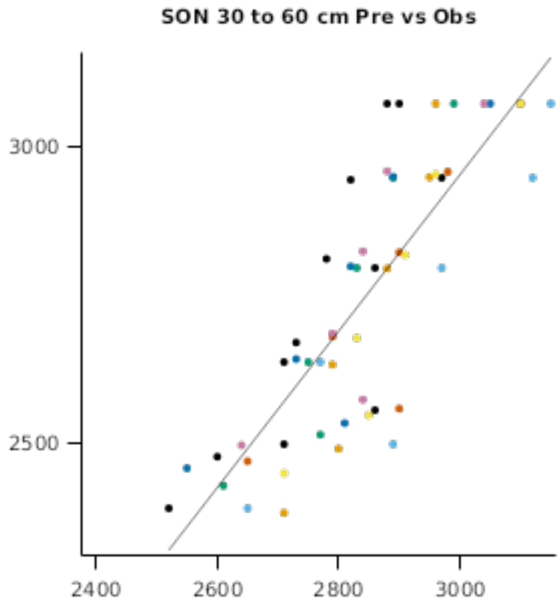



SON 0 to 30 cm
4500
4000
3500
3000
1951
1971
1991
SON 30 to 60 cm
3000
2800
2600
2400
1951
1971
1991
CNR 0 to 30 cm
14
12
10
8
1951
1971
1991
CNR 30 to 60 cm
14
12
10
8
1951
1971
1991

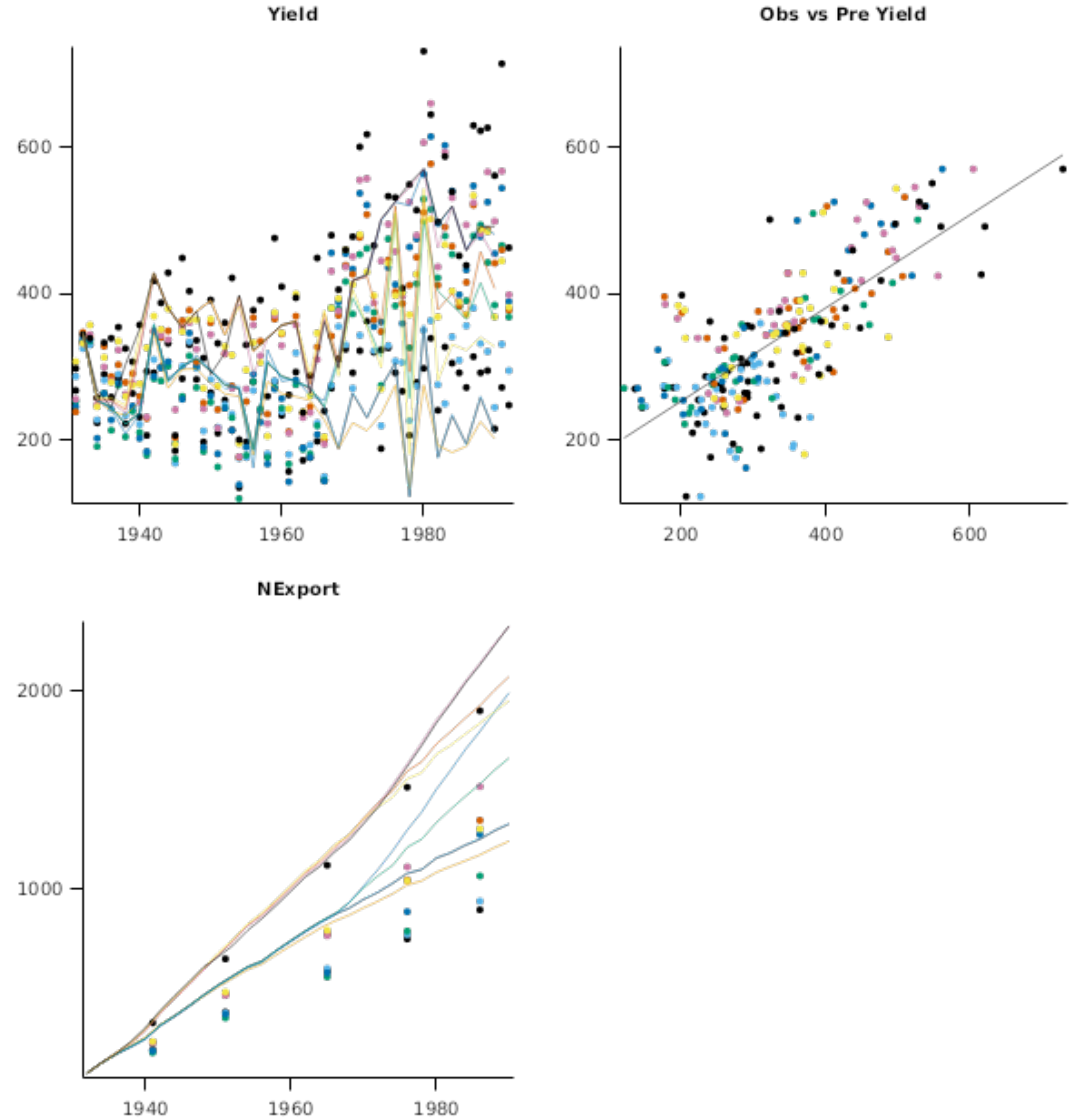

SOC 0 to 30 cm Pre vs Obs
55000
50000
45000
40000
40000
50000


SOC 30 to 60 cm Pre vs Obs
35000
30000
25000
25000
30000
35000


SON 0 to 30 cm Pre vs Obs
4500
4000
3500
3000
3000
3500
4000
4500


SON 30 to 60 cm Pre vs Obs
3000
2500
2400
2600
2800
3000

2.3.1.1.2 Crop



3 Sensibility

3.1 N2O

N2O emmisions are modelled by the APSIM Nutrient model. Further work is encouraged to test and improve this part of the model. Till then, sensibility tests are conducted to ensure that the results from the model meet basic expectations from previous studies.

This very simple sensibility test ensures that the following criteria hold for a range of different farming systems across different geographical locations: a) Oil Palm in Papua New Guinea b) Wheat in Southern Queensland, Australia. c) Sugarcane in Northern Queensland, Australia d) Maize in Malawi, Africa.

Tests check that the following are maintained:

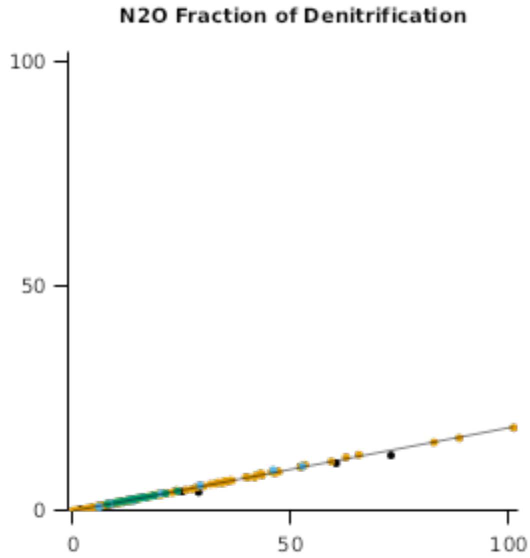
1. Total annual N2O losses from denitrification are relatively low (less than 25 kg N/ha/y)
2. N2O losses from denitrification lie within 10% and 25% of total N losses from denitrification
3. Total annual N2O losses from nitrification are very low (less than 3 kg N/ha/y)

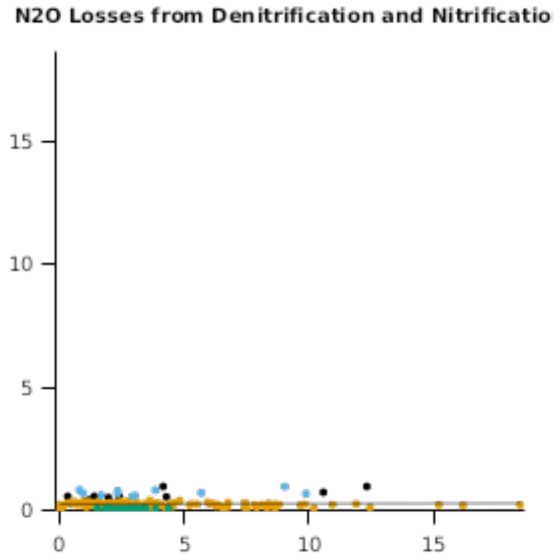
OilPalm

Wheat

SugarCane

LowInputMaize



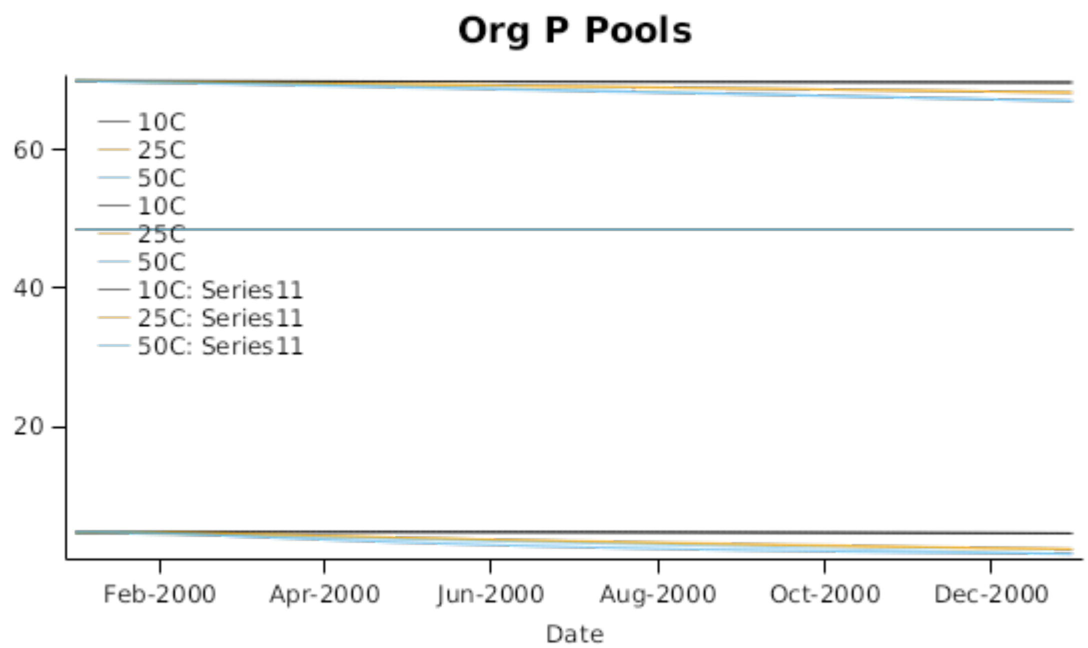


3.2 Incubation

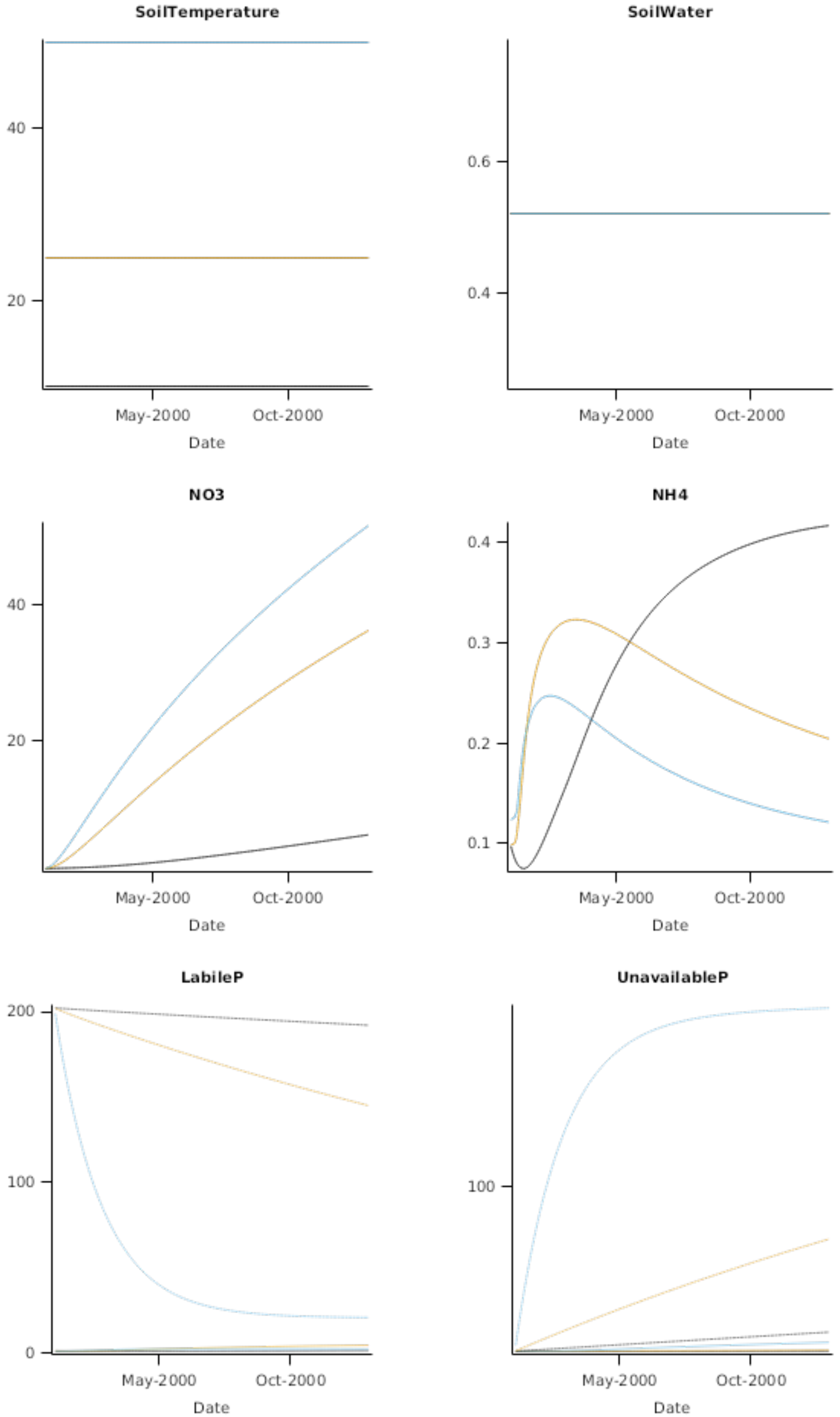
List of experiments.

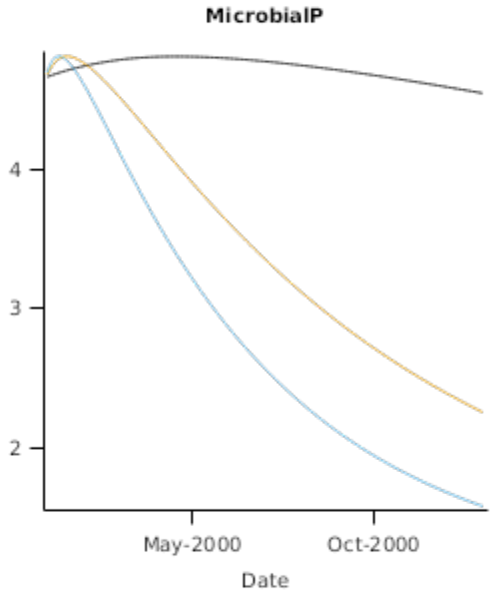
Experiment Name	Design (Number of Treatments)
Incubation	Temperature x InitialP (6)

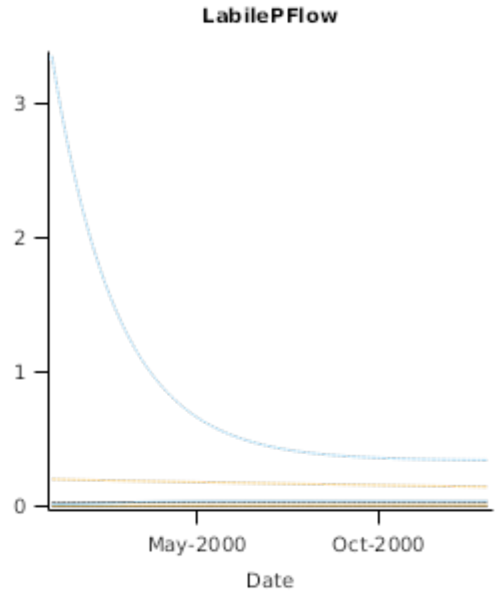
3.2.1 Incubation

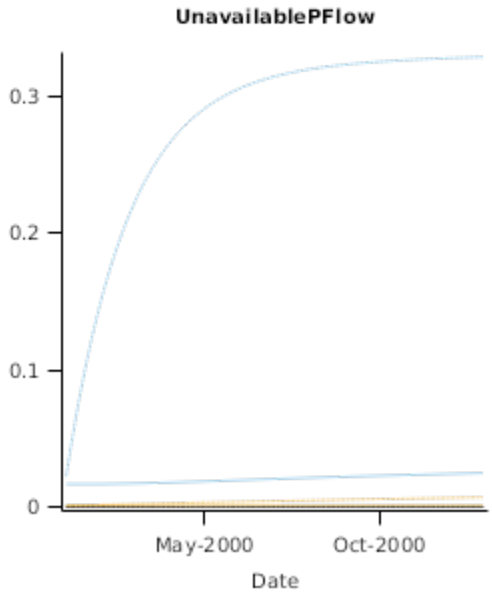


3.2.1.1 Graphs


SoilTemperature
40
20
May-2000
Oct-2000
Date
SoilWater
0.6
0.4
May-2000
Oct-2000
Date
NO3
40
20
May-2000
Oct-2000
Date
NH4
0.4
0.3
0.2
0.1
May-2000
Oct-2000
Date
LabileP
200
100
0
May-2000
Oct-2000
Date
UnavailableP
100
May-2000
Oct-2000
Date







4 References

Huth, N. I., Thorburn, P. J., Radford, B. J., Thornton, C. M., 2010. Impacts of fertilisers and legumes on N2O and CO2 emissions from soils in subtropical agricultural systems: A simulation study. Agriculture Ecosystems and Environment 136 (3-4), 351-357.

Paydar, Z., Huth, N., Ringrose-Voase, A., Young, R., Bernardi, T., Keating, B., Cresswell, H., 2005. Deep drainage and land use systems. Model verification and systems comparison. Australian Journal of Agricultural Research 56 (9), 995-1007.

Rasmussen, P E, Albrecht, S L,, Smiley, R W, 1998. Soil C and N changes under tillage and cropping systems in semi-arid Pacific Northwest agriculture. Soil and Tillage Research 47, 197-205.

Schultz, J.E., 1995. Crop production in a rotation trial at Tarlee, South Australia. Australian Journal of Experimental Agriculture 35 (865-876).

Young, R. R., Wilson, B., Harden, S., Bernardi, A., 2009. Accumulation of soil carbon under zero tillage cropping and perennial. AUSTRALIAN JOURNAL OF SOIL RESEARCH 47 (3), 273-285.