



1 The APSIM Nutrient Model

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

This work builds upon earlier APSIM soil organic matter models such as SoilN ([Probert et al., 1998](#)).

The N pools / flows simulate the nitrate content of each soil layer. Much of the capability has been taken from implementation in the APSIM SoilN model ([Probert et al., 1998](#)), which was derived from approaches in CERES-Maize ([Jones et al., 1986](#)).

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.

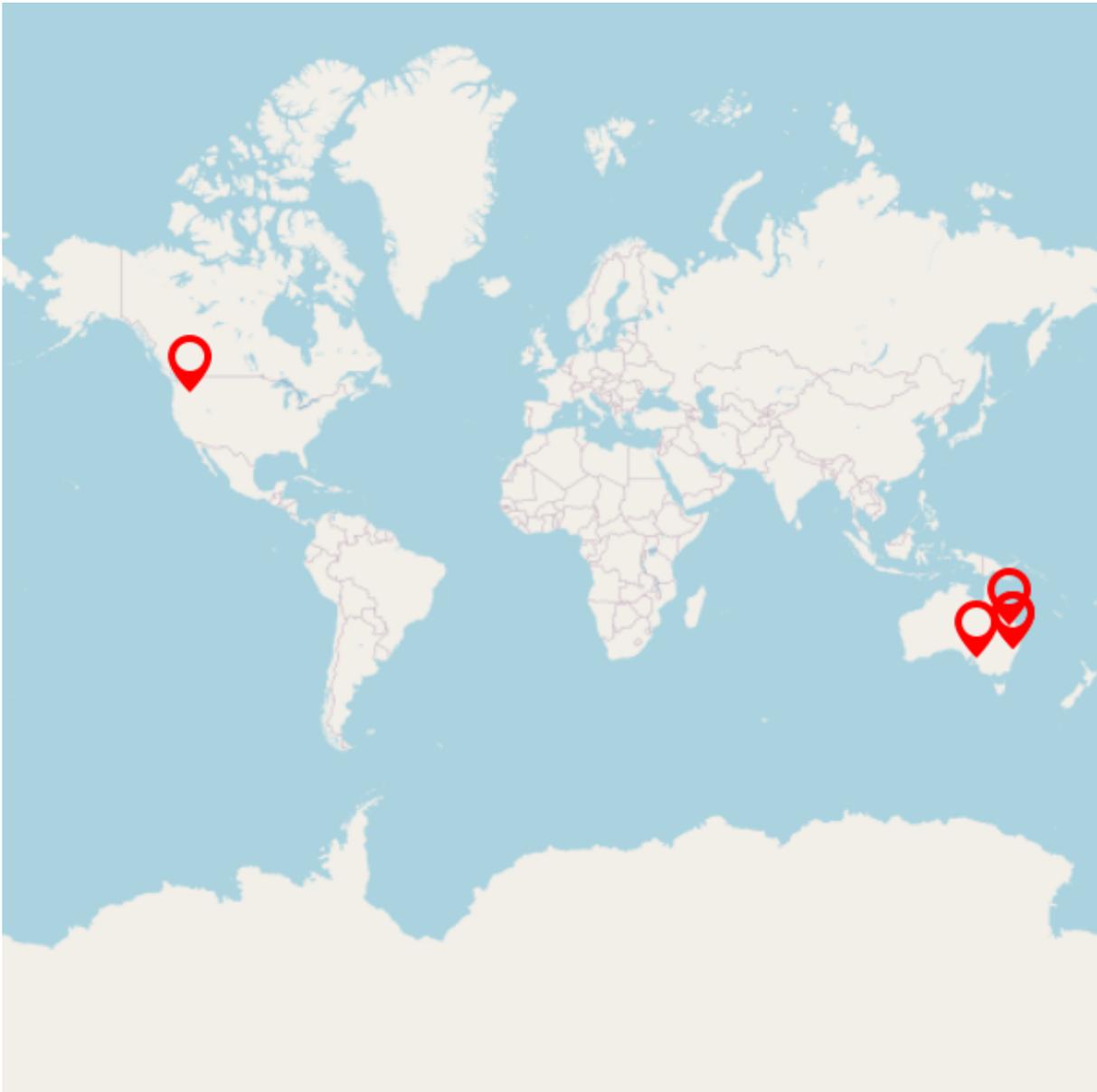
1.3 Solutes

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.

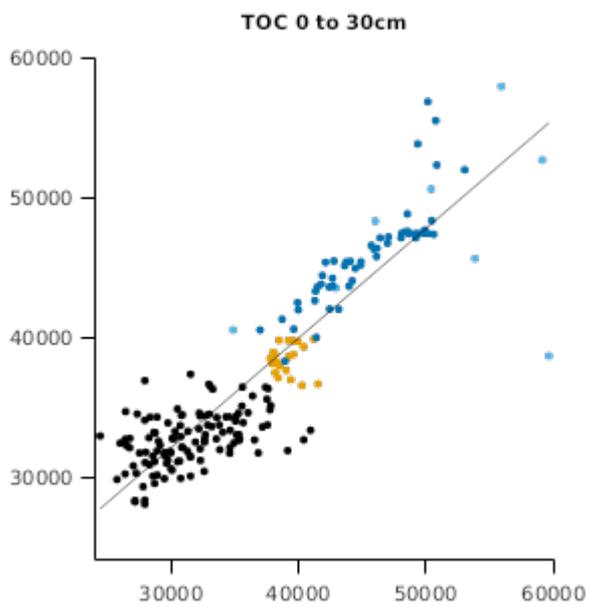
2 Validation

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 Map



2.2 Combined Results



2.3 Australia

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

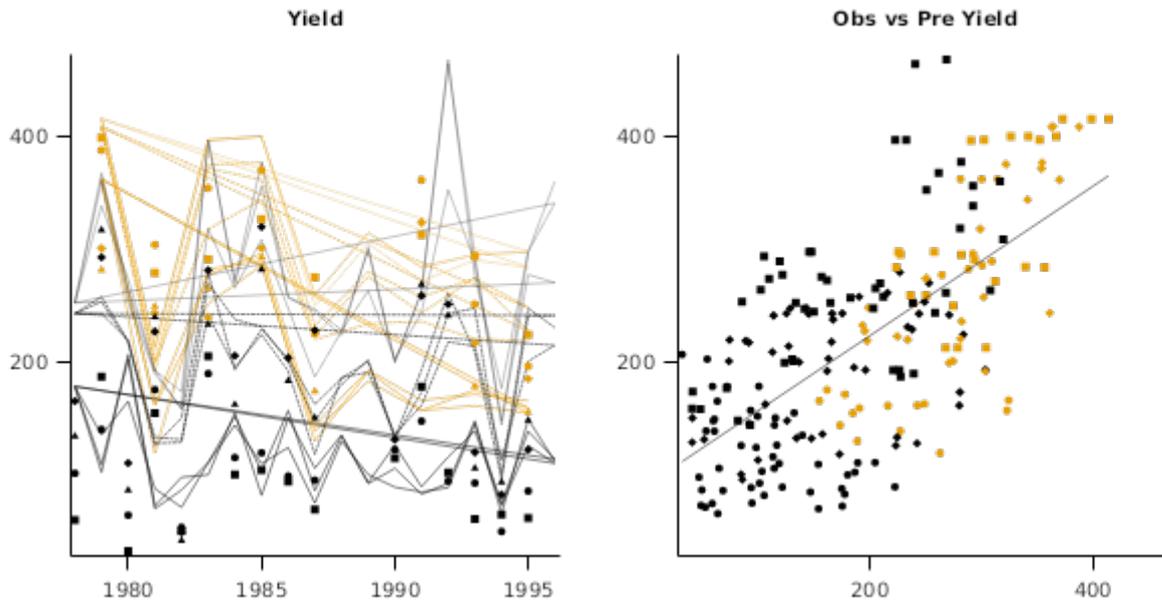
2.3.1 Tarlee

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).

2.3.1.1 List of experiments

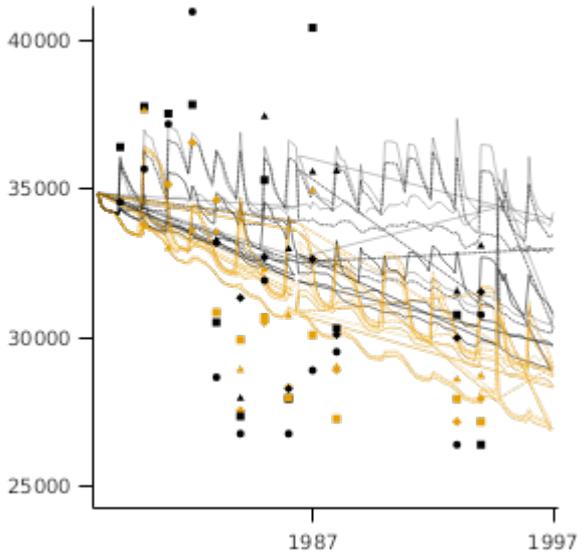
Experiment Name	Design (Number of Treatments)
Tarlee	Rotation x Stubble x N (18)

2.3.1.2 Crop

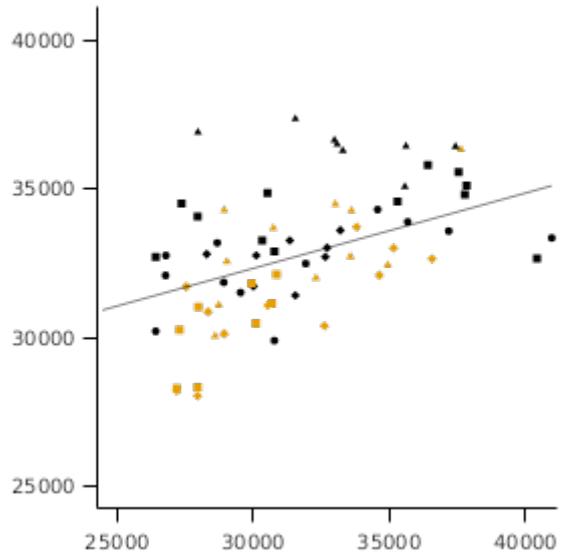


2.3.1.3 Soil

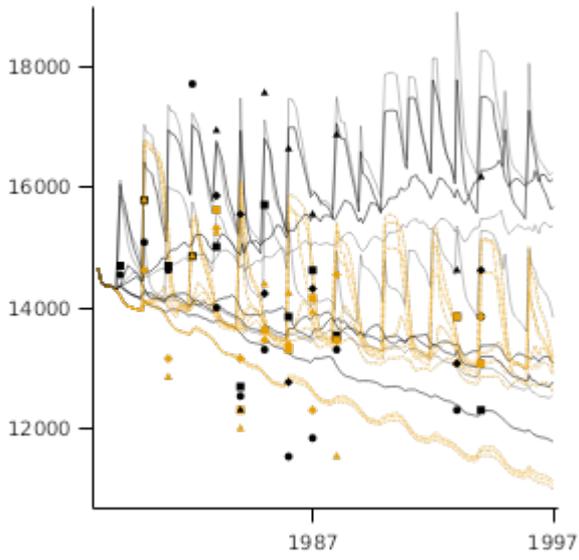
TOC 30cm



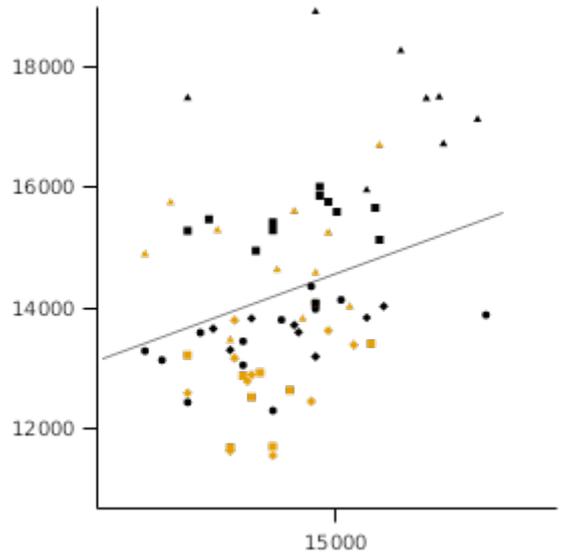
Obs vs Pre TOC 30cm

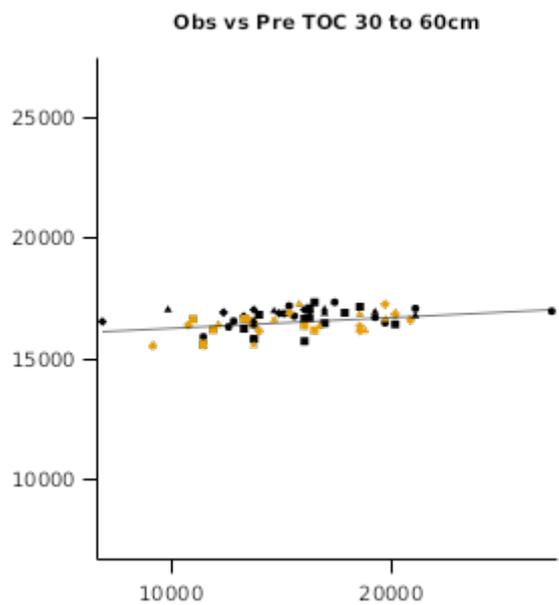
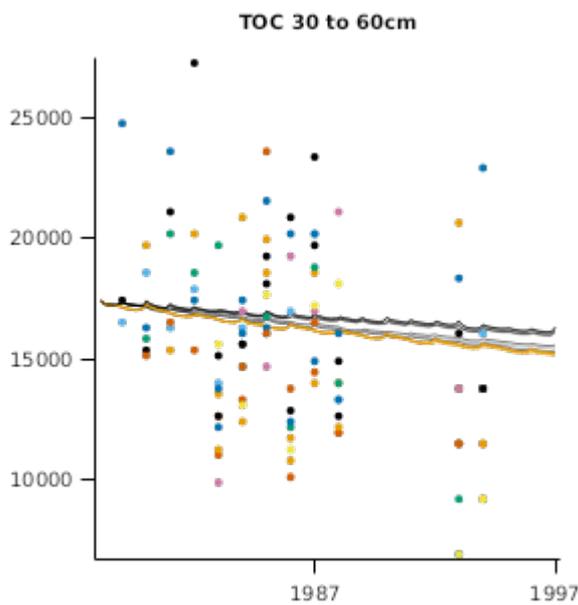
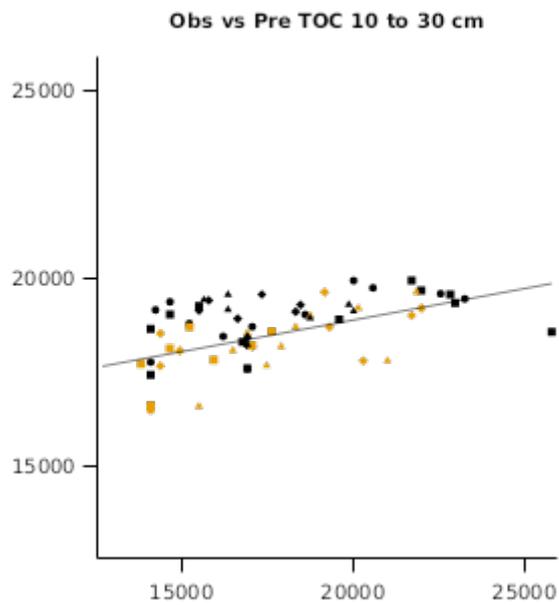
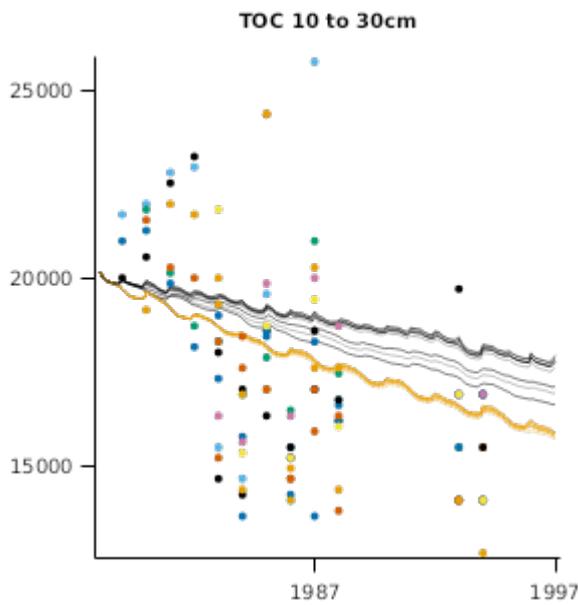


TOC 0 to 10cm



Obs vs Pre TOC 10cm





2.3.2 Hudson

This dataset demonstrates cropping system performance and soil carbon dynamics under continuous winter cereal versus perennial 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](#).

2.3.2.1 List of experiments

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

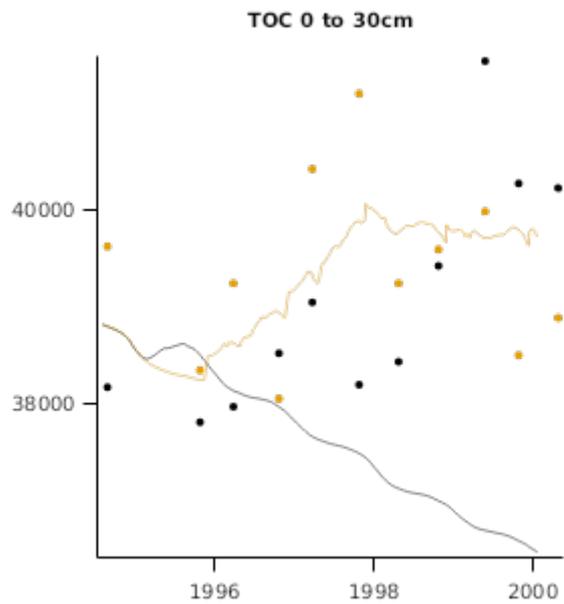
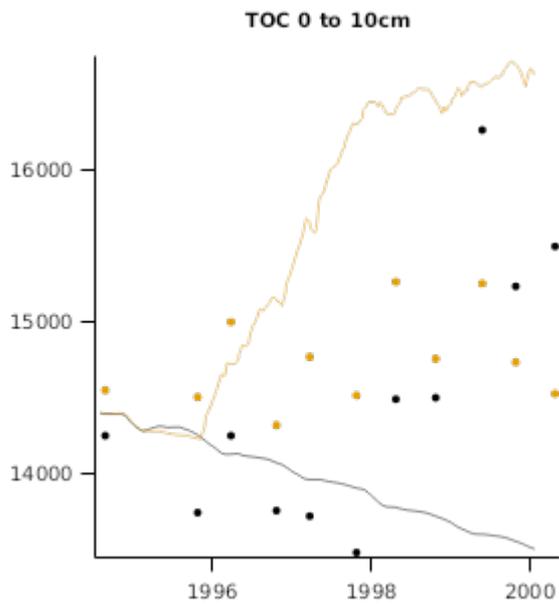
2.3.2.2 Hudson

Biomass

Yield

LAI

2.3.2.3 Graphs



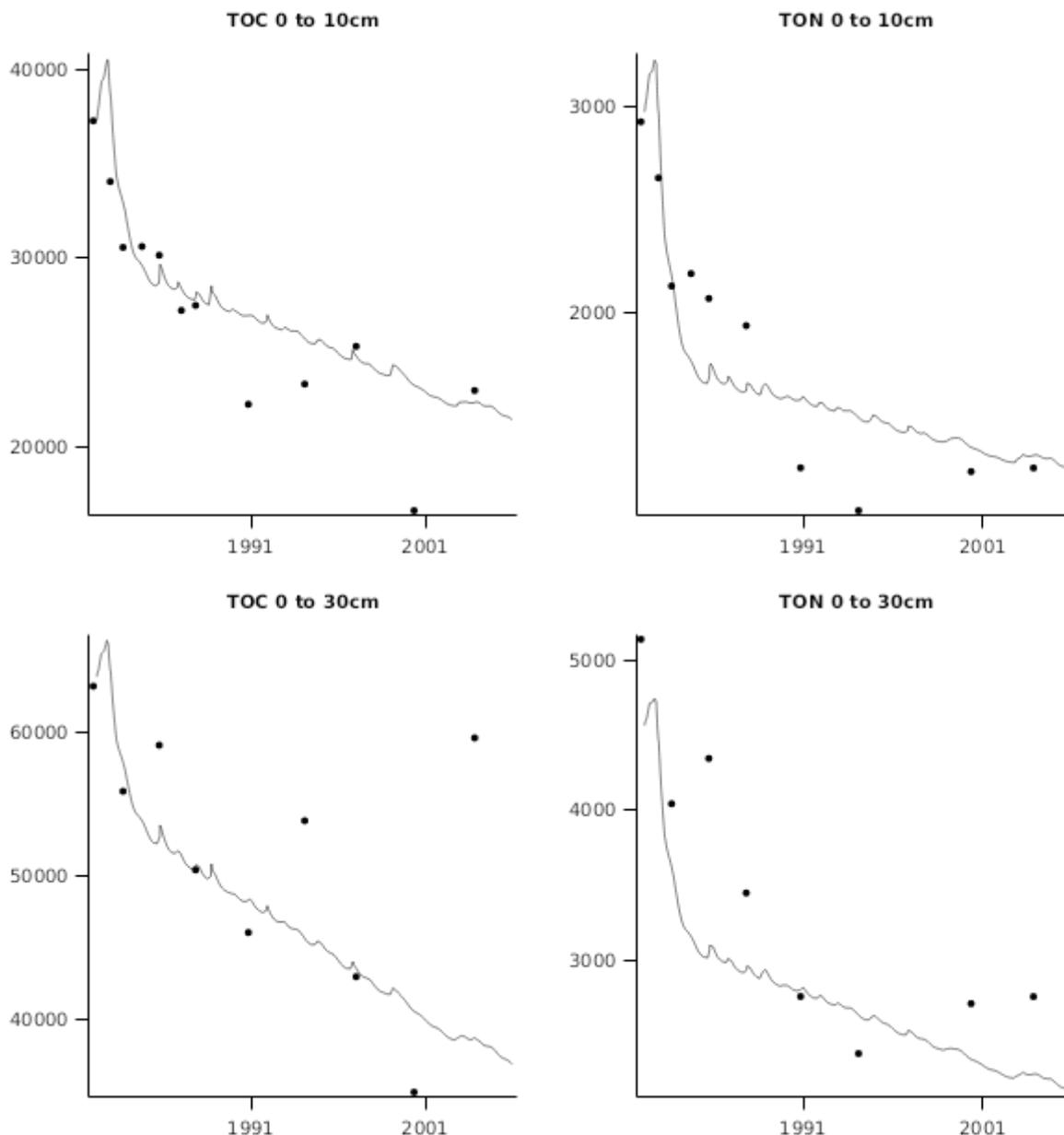
2.3.3 Brigalow Catchment Study

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.

2.3.3.1 List of experiments

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

2.3.3.2 Graphs



2.3.4 Horsham

2.3.4.1 List of experiments

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

2.4 North America

2.4.1 Pendleton

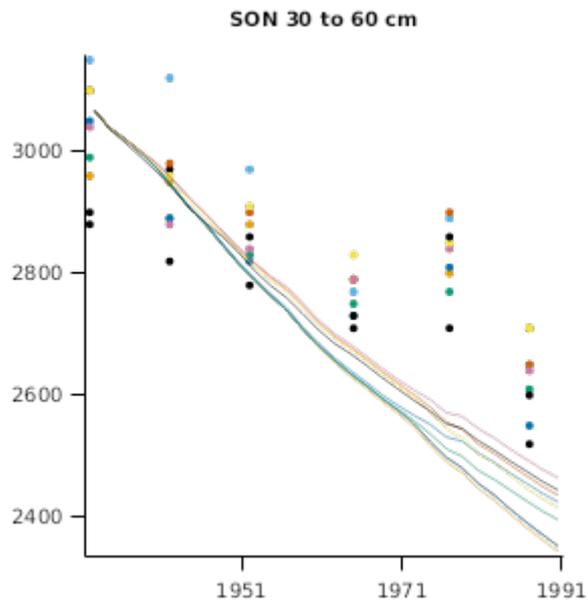
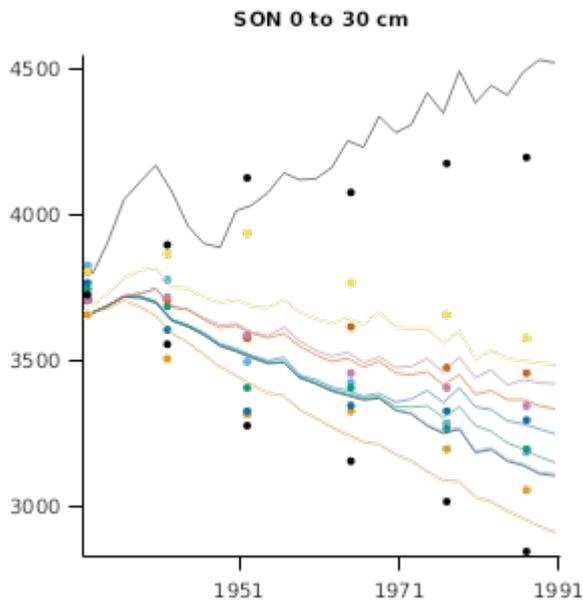
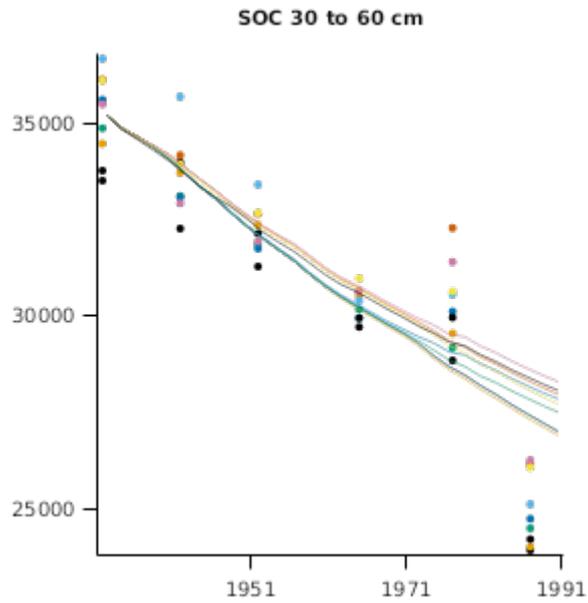
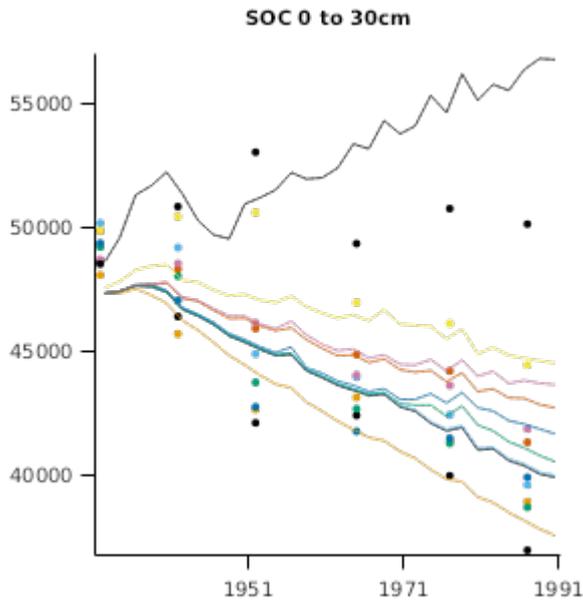
The Pendleton Long Term Experiment ([Rasmussen et al., 1998](#)) was established in 1931 at Oregon State University's Columbia Basin Agricultural Research Center near Pendleton, OR (45.72 N, 118.63 W). It consisted of nine treatments

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.

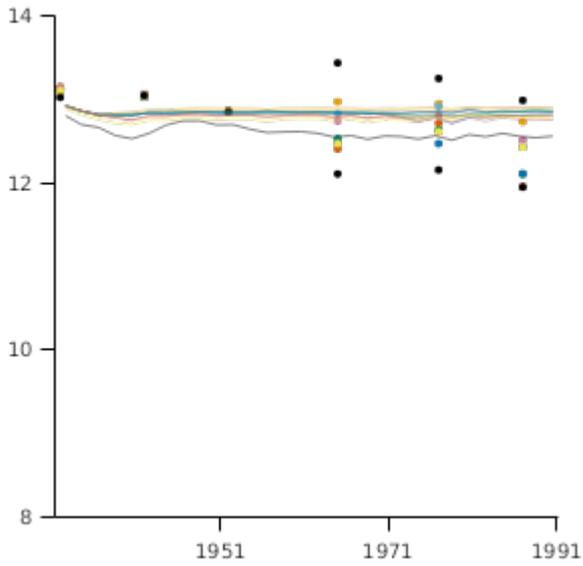
2.4.1.1 List of experiments

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

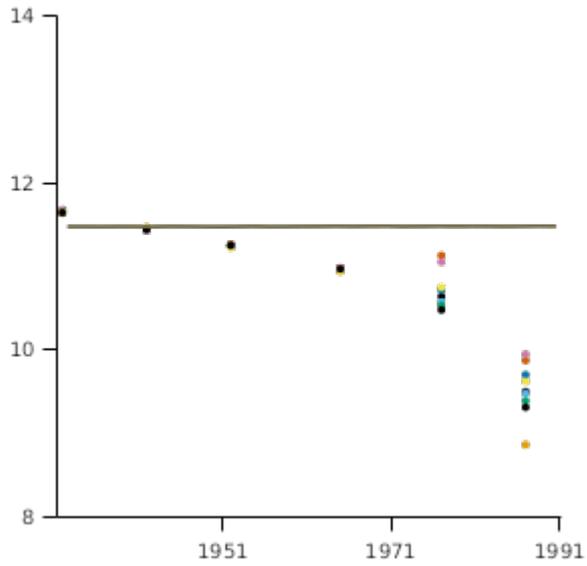
2.4.1.2 Pendleton



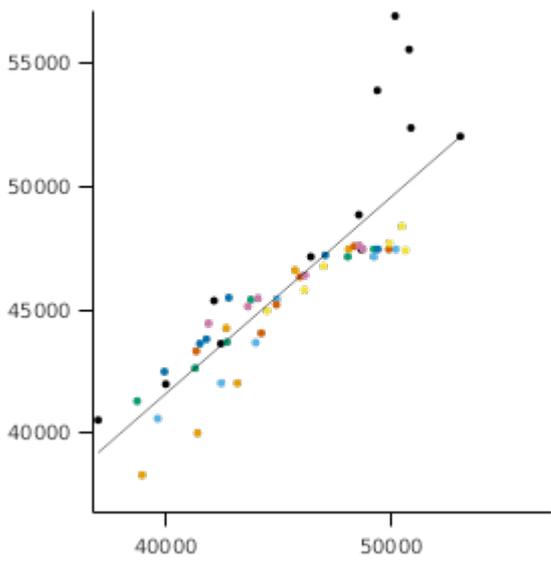
CNR 0 to 30 cm



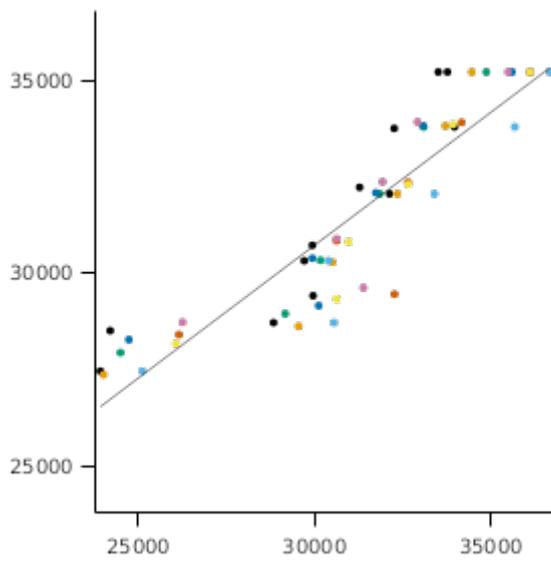
CNR 30 to 60 cm



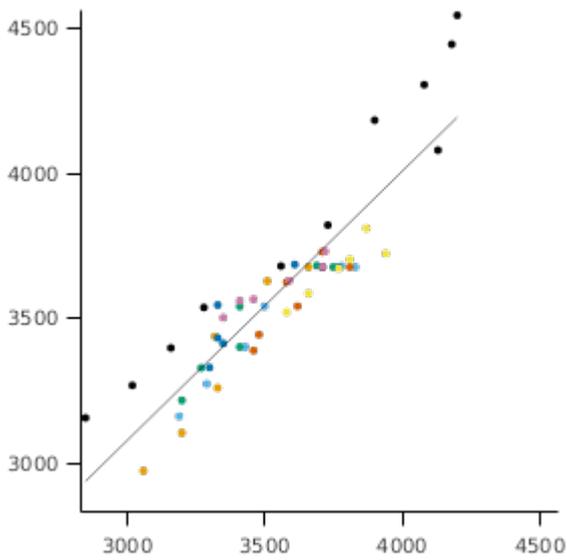
SOC 0 to 30 cm Pre vs Obs



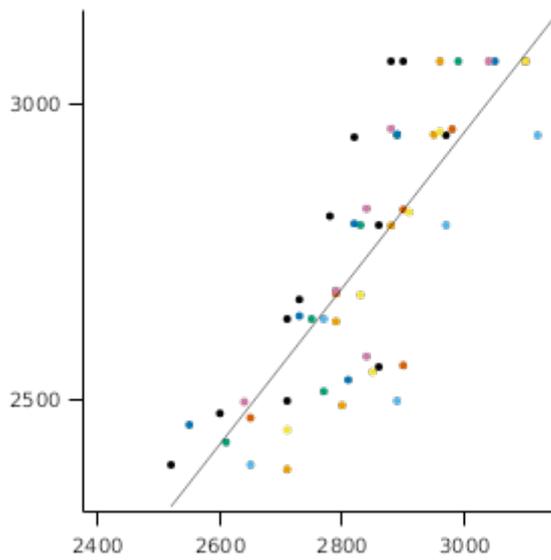
SOC 30 to 60 cm Pre vs Obs

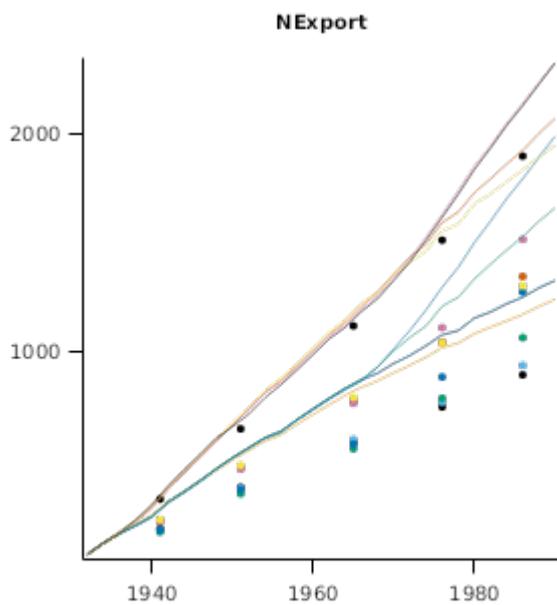
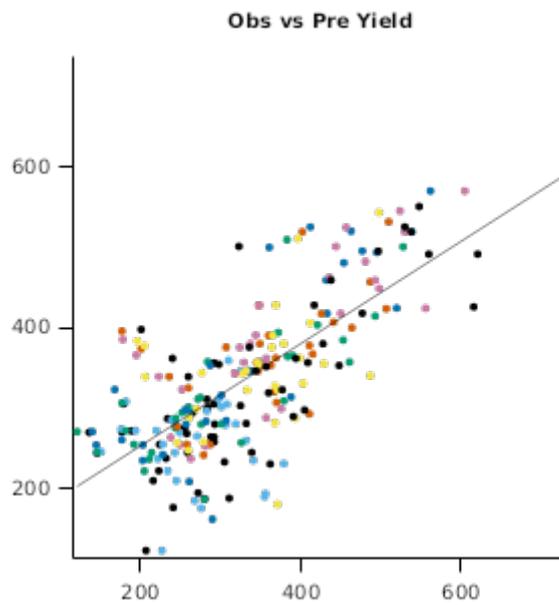
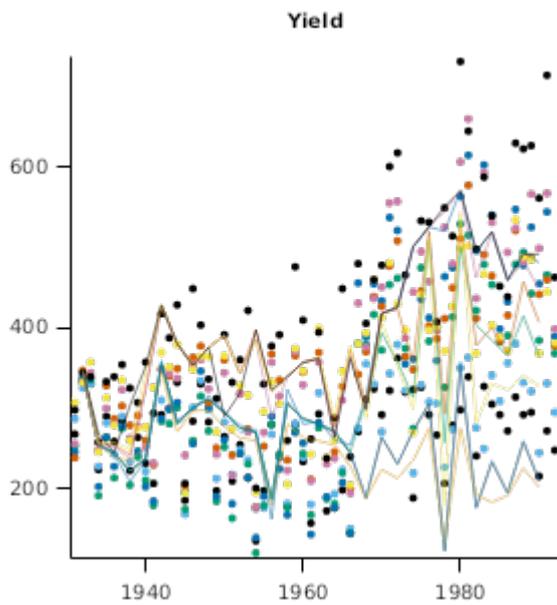


SON 0 to 30 cm Pre vs Obs



SON 30 to 60 cm Pre vs Obs





3 Sensibility

3.1 N₂O

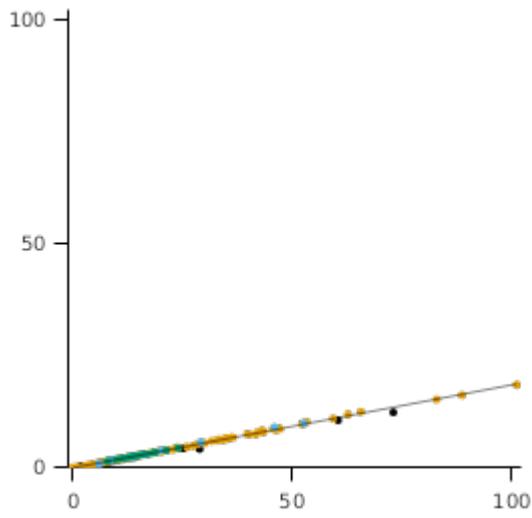
N₂O emissions are modelled by the APSIM Nutrient model. Further work is encouraged to test and improve this part of the model. Till then, sensibility tests are conducted to ensure that the results from the model meet basic expectations from previous studies.

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.

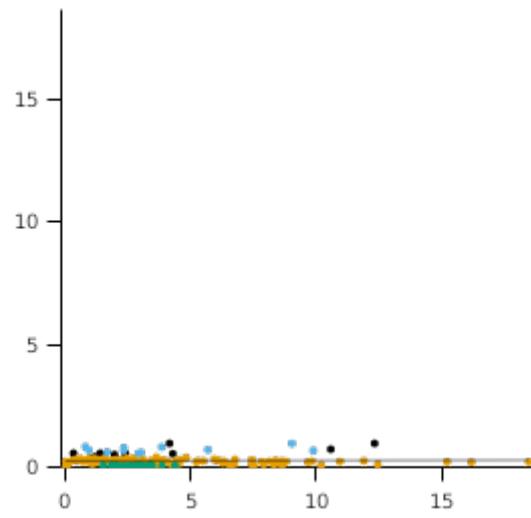
Tests check that the following are maintained:

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)

N2O Fraction of Denitrification

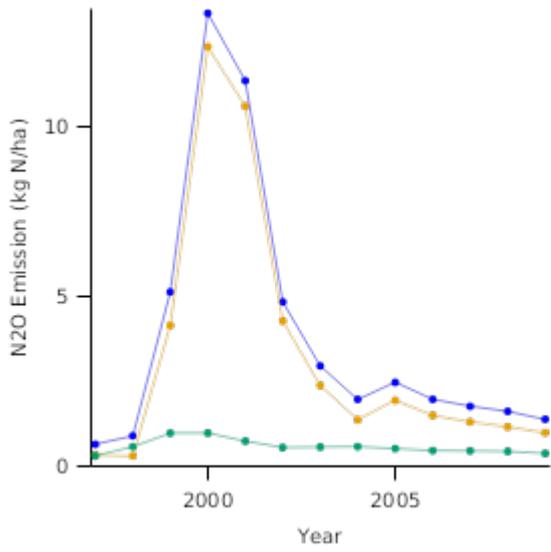


N2O Losses from Denitrification and Nitrificatio

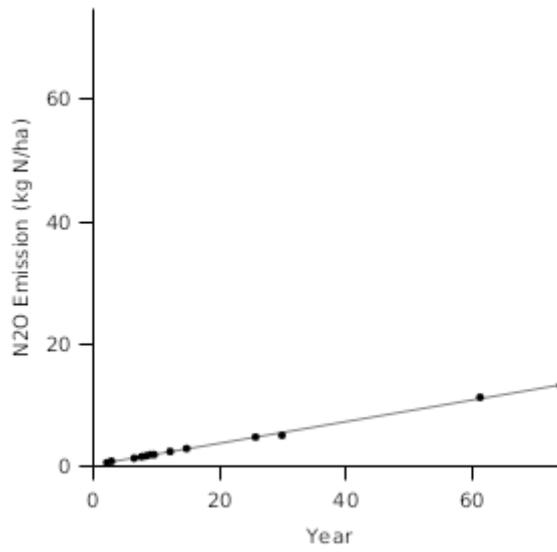


3.1.1 OilPalm

N2O Emissions

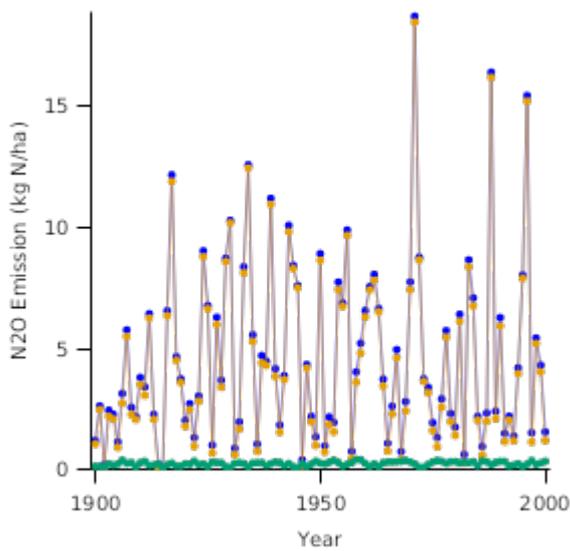


N2O Fraction of Emission

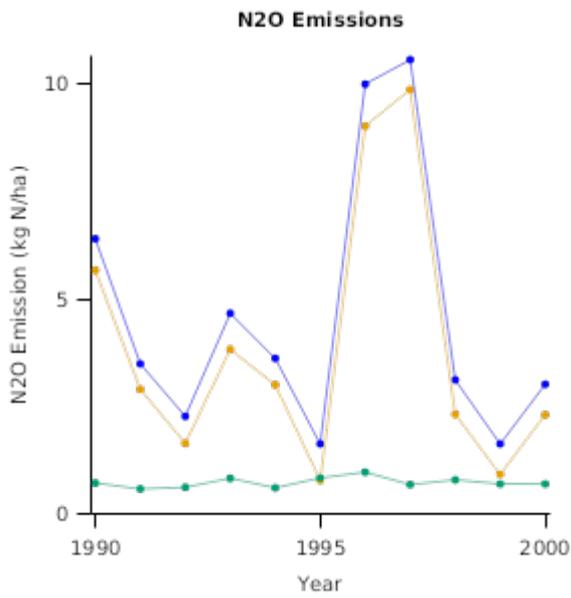


3.1.2 Wheat

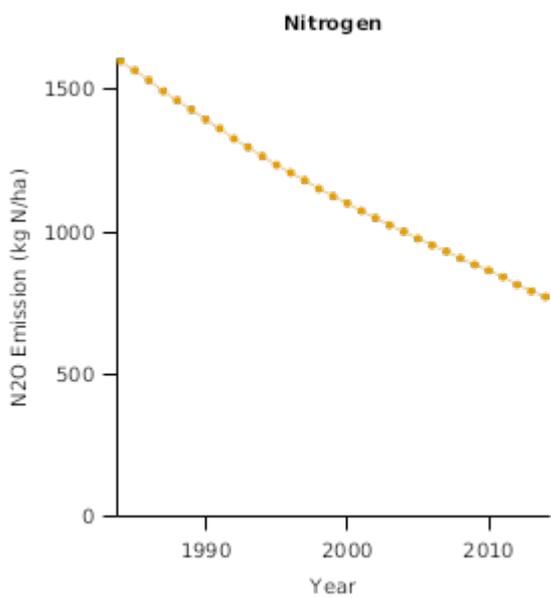
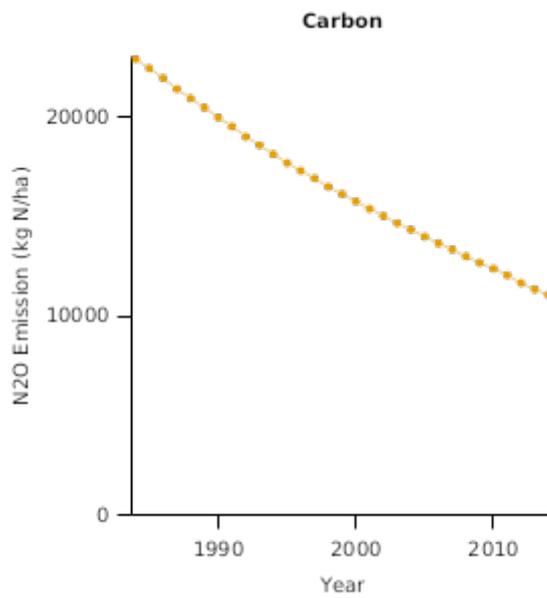
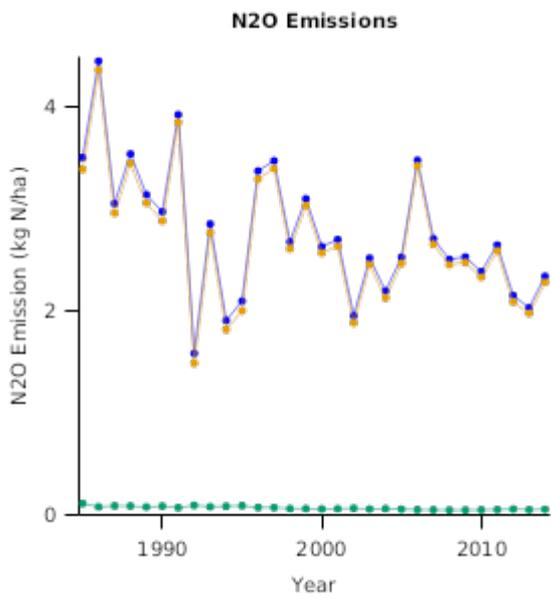
N2O Emissions



3.1.3 SugarCane



3.1.4 LowInputMaize

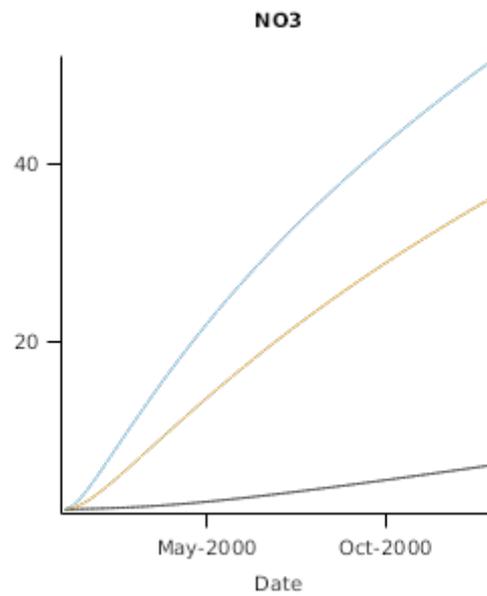
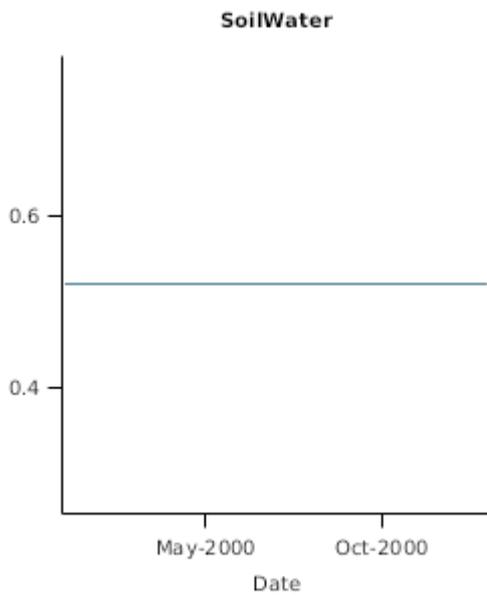
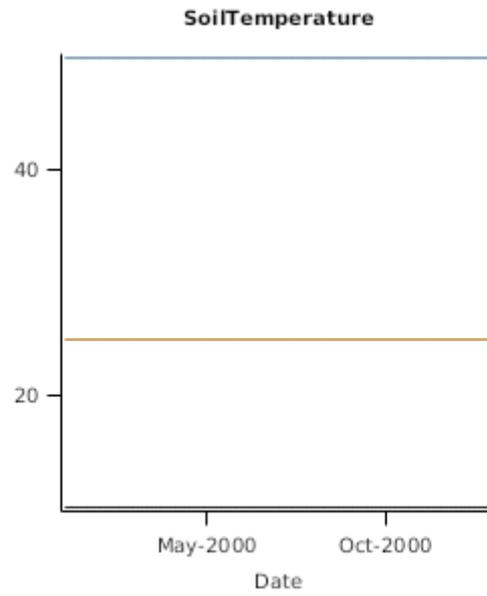
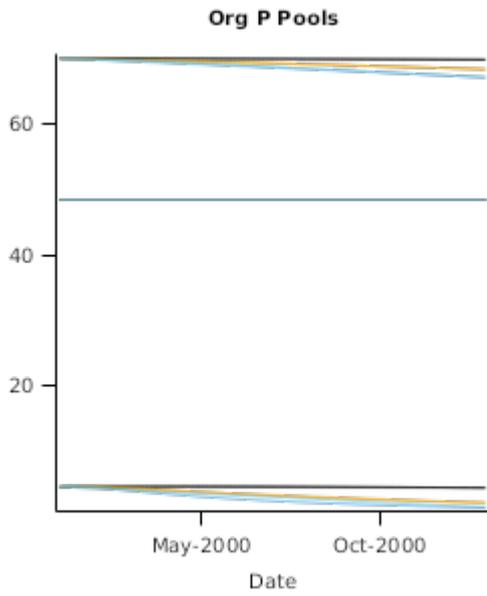


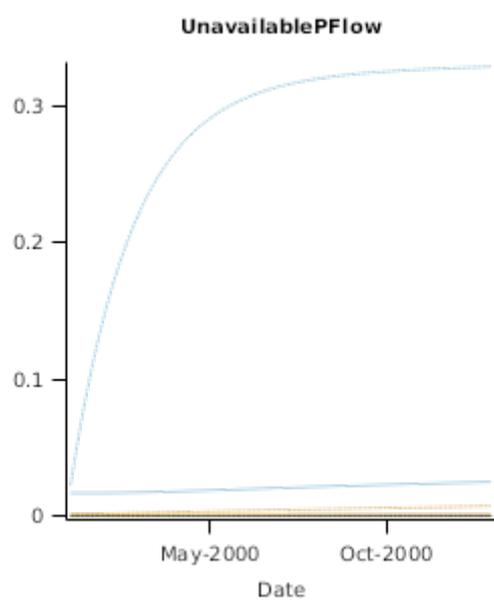
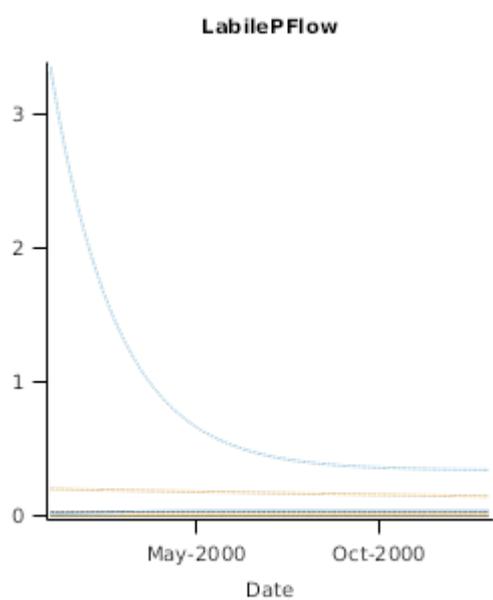
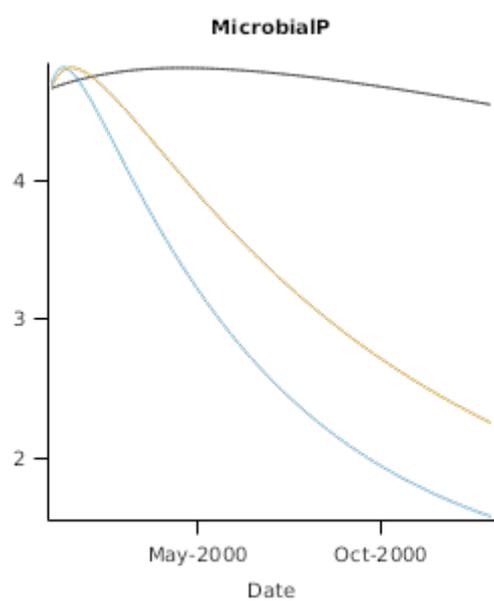
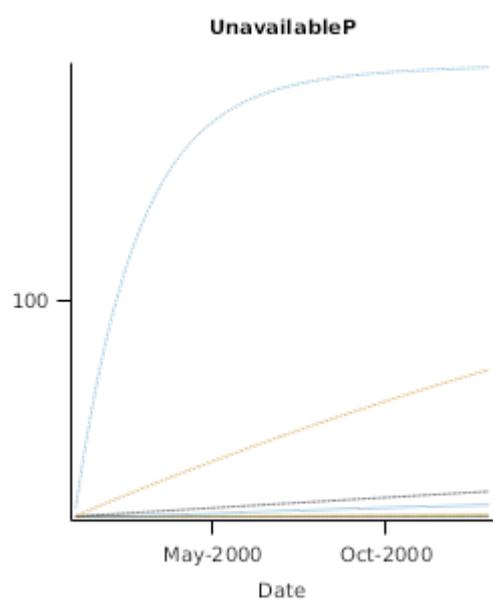
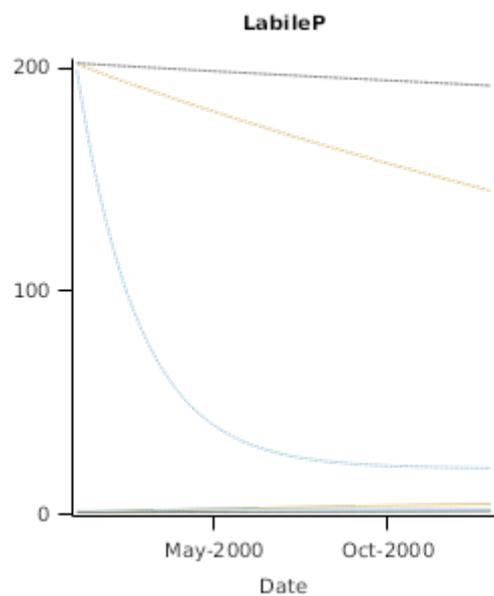
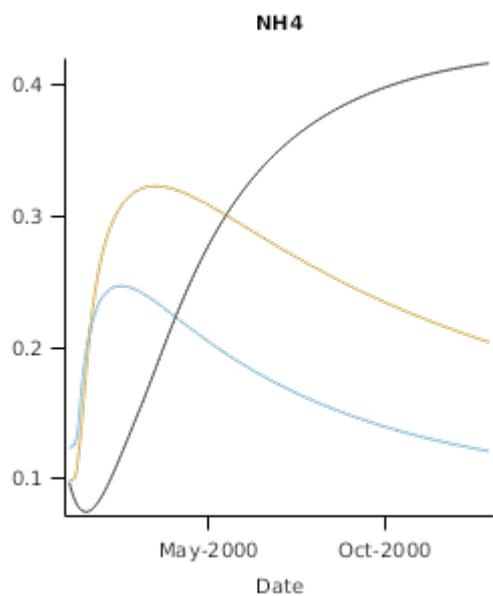
3.2 Incubation

3.2.1 List of experiments

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

3.2.2 Incubation





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.

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- 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.
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