Landcare Research
Manaaki Whenua

NZ-DNDC: Model developments and modifications for simulating GHG emissions from grazed pastures

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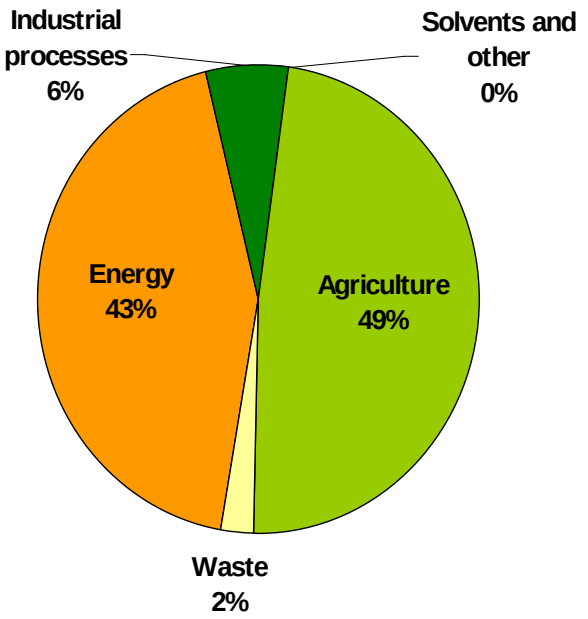
Agriculture is a major contributor to NZ's GHG emissions

Population	
Humans	**4,230,700**
Beef cattle	**4,393,620**
Dairy cattle	**5,260,850**
Sheep	**38,460,480**

NZ Greenhouse Gas emissions by sector 2007



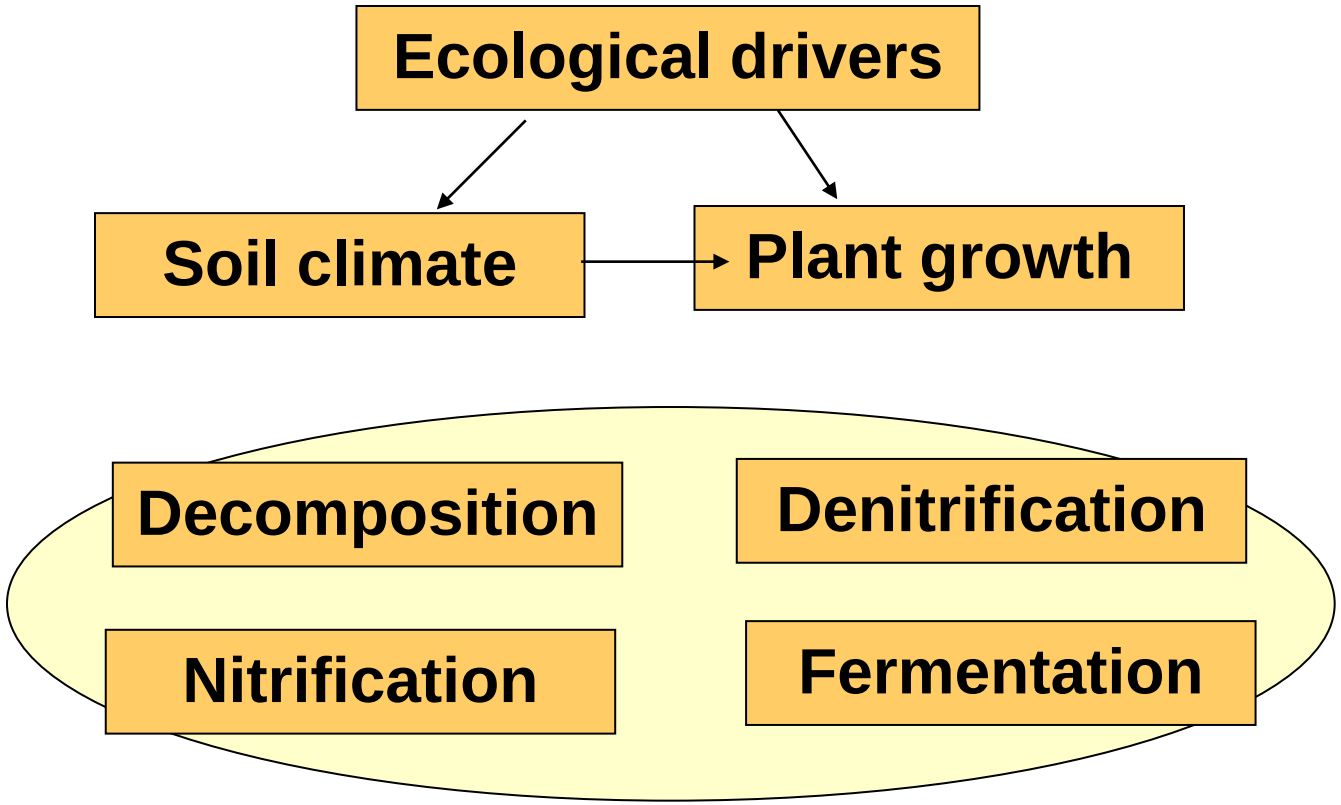
Agricultural emissions (Gg CO_2e/y)

Enteric Fermentation (CH_4)	23,326.4
Manure Management	787.1
Agricultural soils (N_2O)	12,298.1
Prescribed and field burning of savannahs	18.5

16% of total emissions

Data sources: MfE, MAF and Statistics New Zealand

DNDC: A process-based model



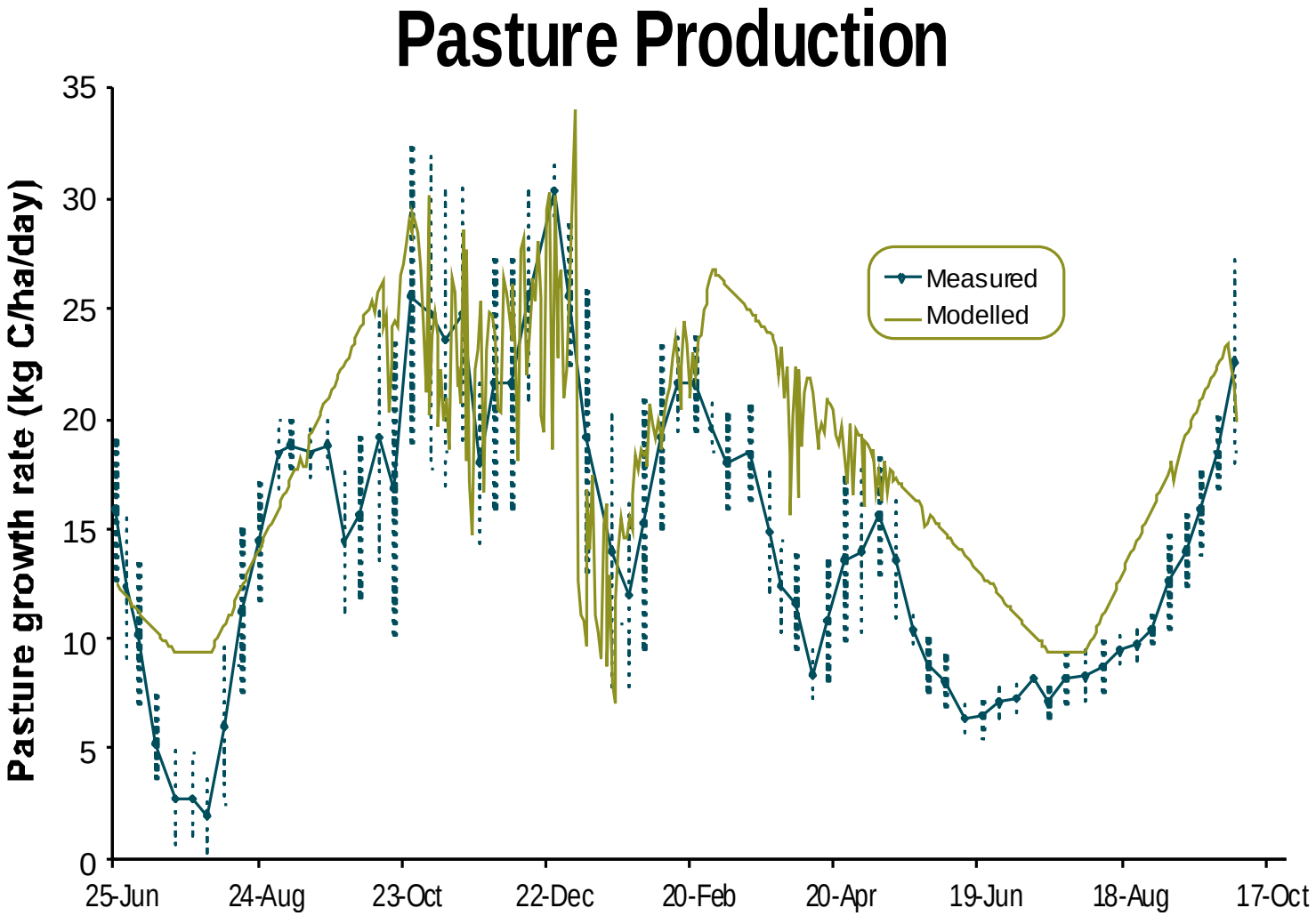
Initial issues with the application of DNDC model to grazed pastures

- Cropping model – perennial pasture growth not modelled well
- No grazing component - N intake and deposition (frequency, time)
- Could not simulate measured saturated soil conditions
- Northern hemisphere specific
- Incorrect WFPS threshold for denitrification to occur

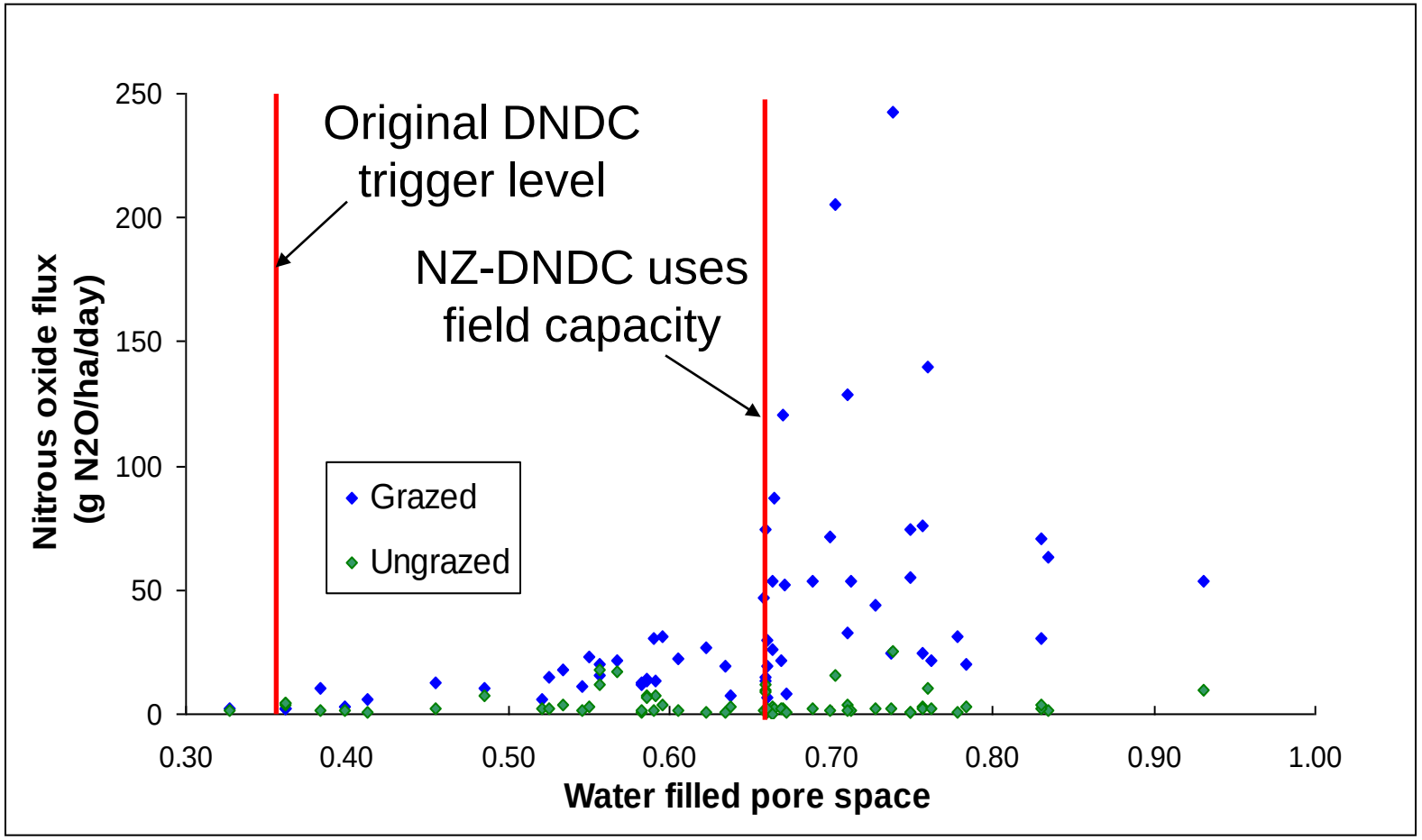
Modifications to ‘NZ-DNDC’

- Perennial pasture growth module developed.
- Grazing simulated from animal dry matter intake and N excretion.
- Soil surface temperature/air temperature relationship modified.

Measured and modelled pasture growth

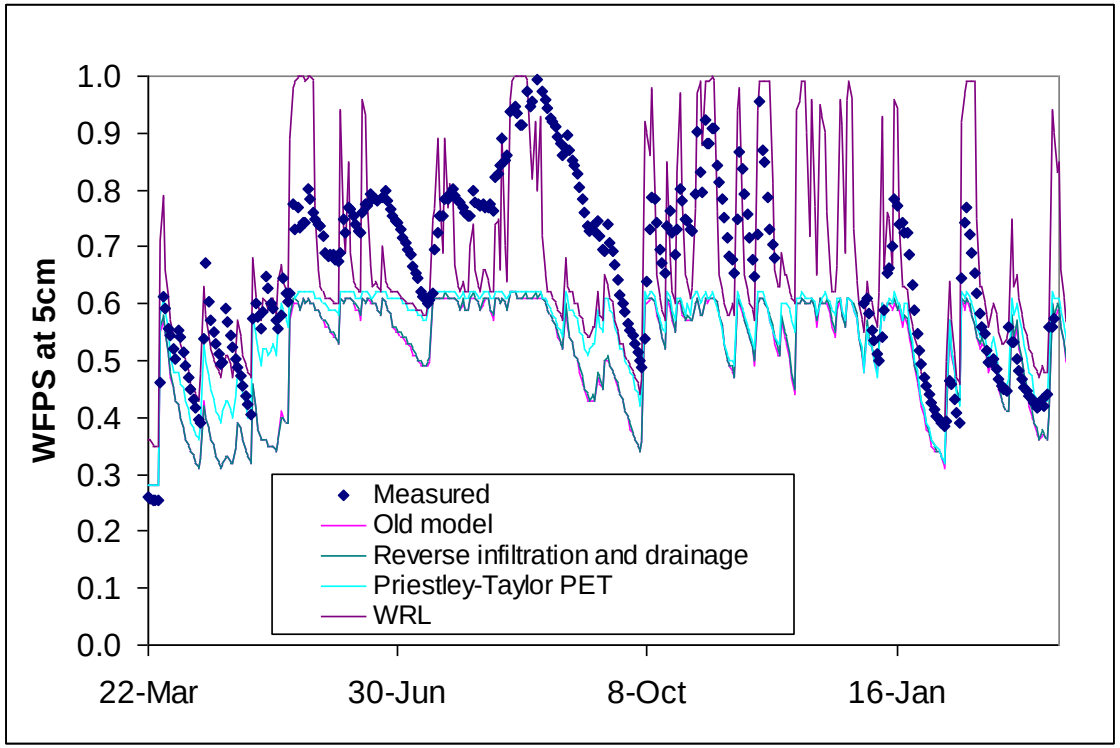


Modifications: Denitrification trigger*



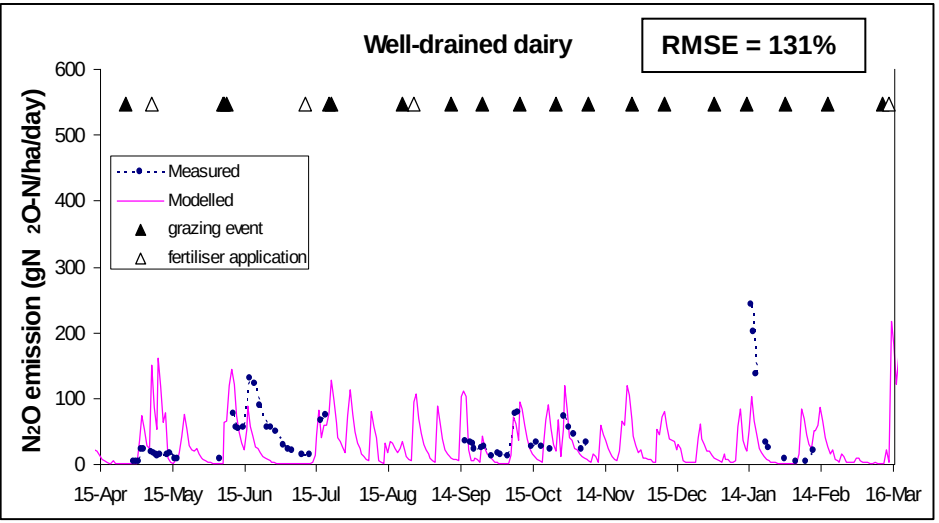
*This has since been superceded by the “N2O balloon” method of calculating the soil anaerobic volume fraction

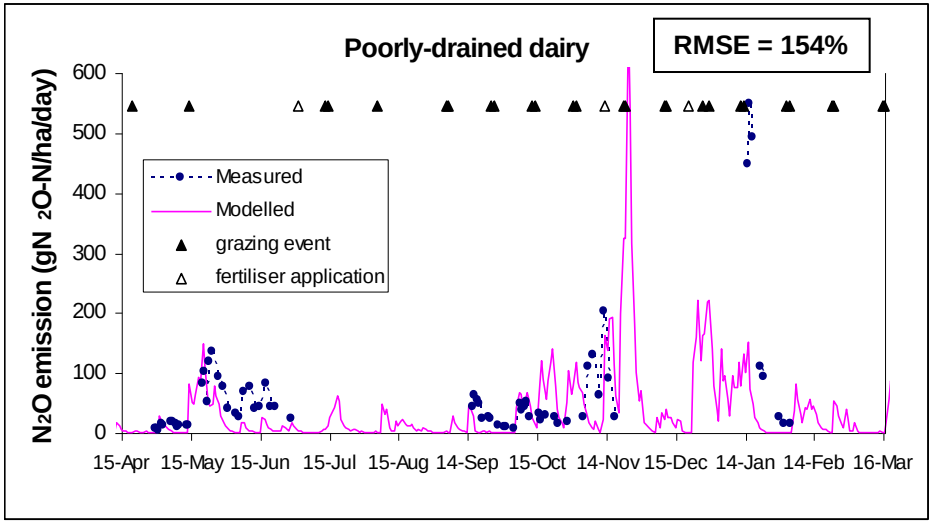
Modifications: Water balance

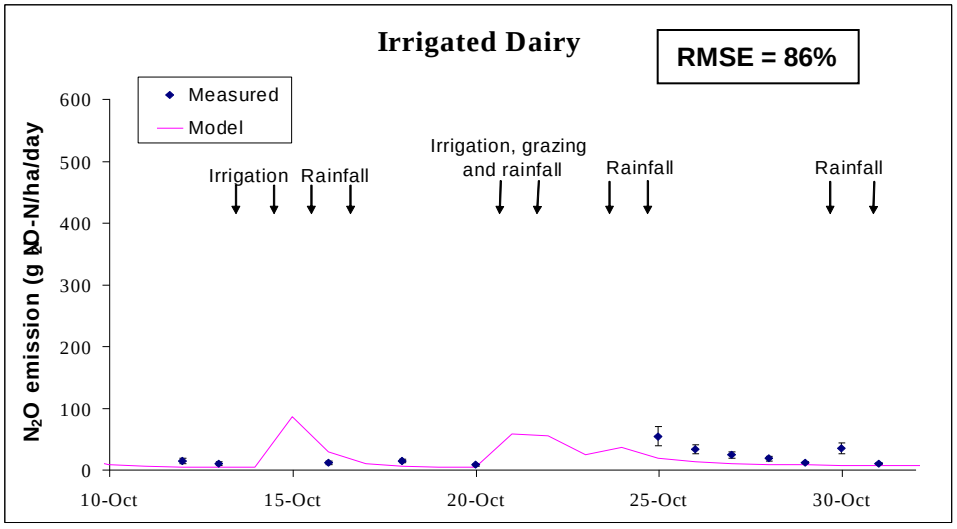


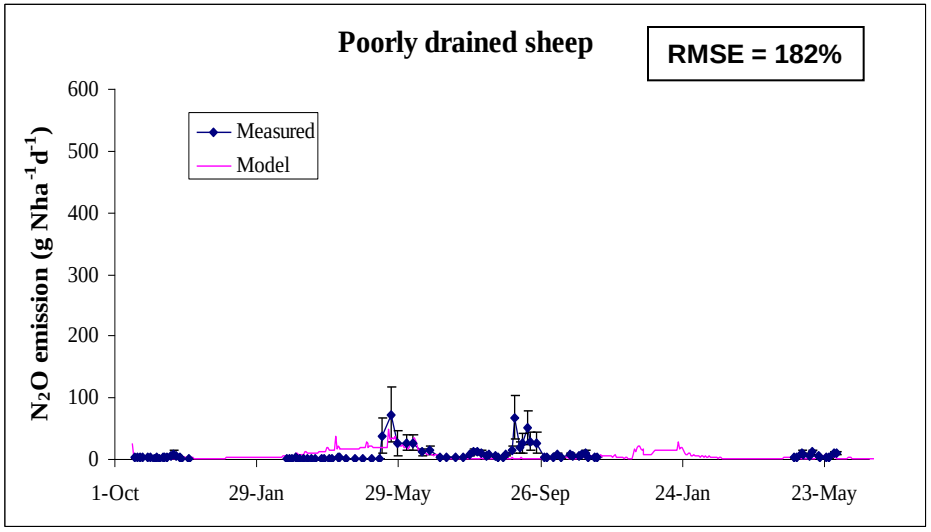
- Reversed the order of infiltration and drainage processes.
- Switched from Thornthwaite to Priestley-Taylor PET equation.
- Added water retention layer

Site level validation

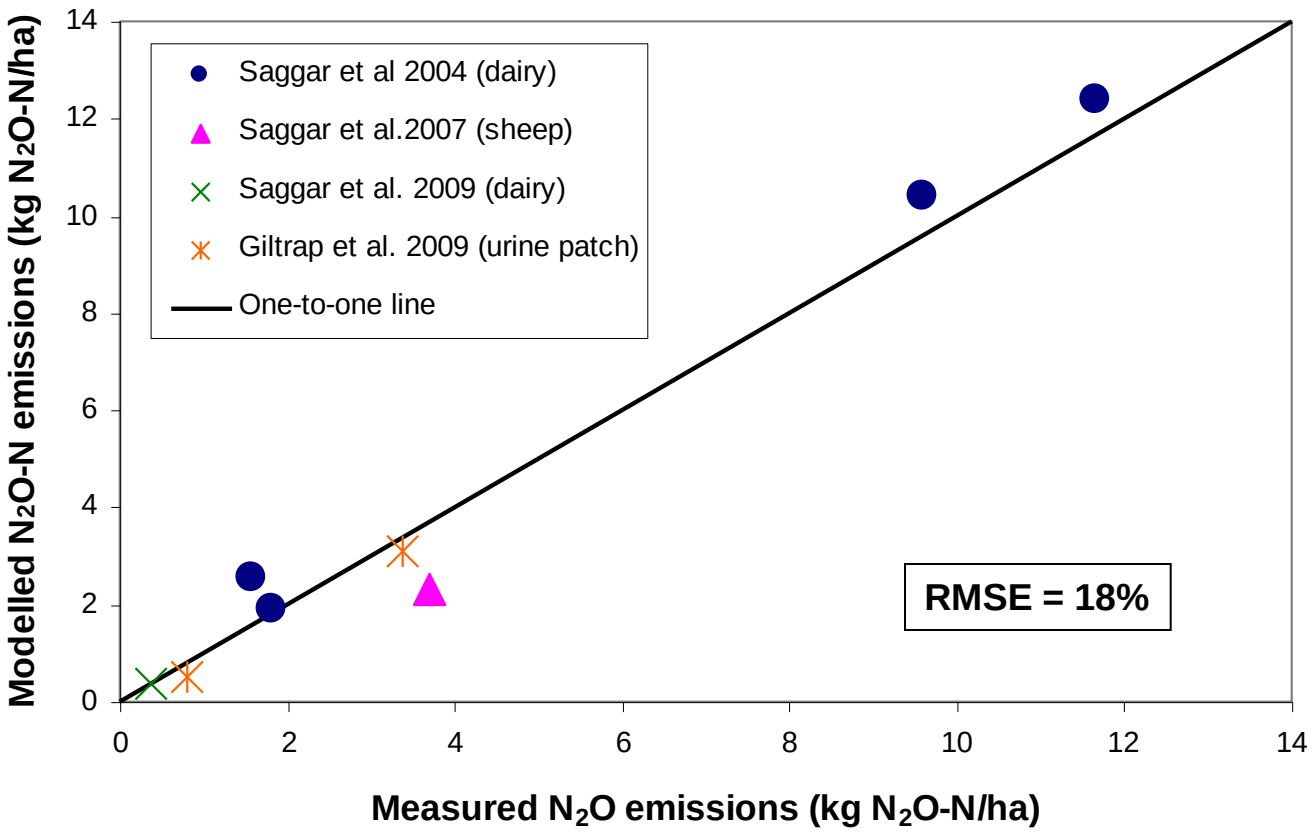




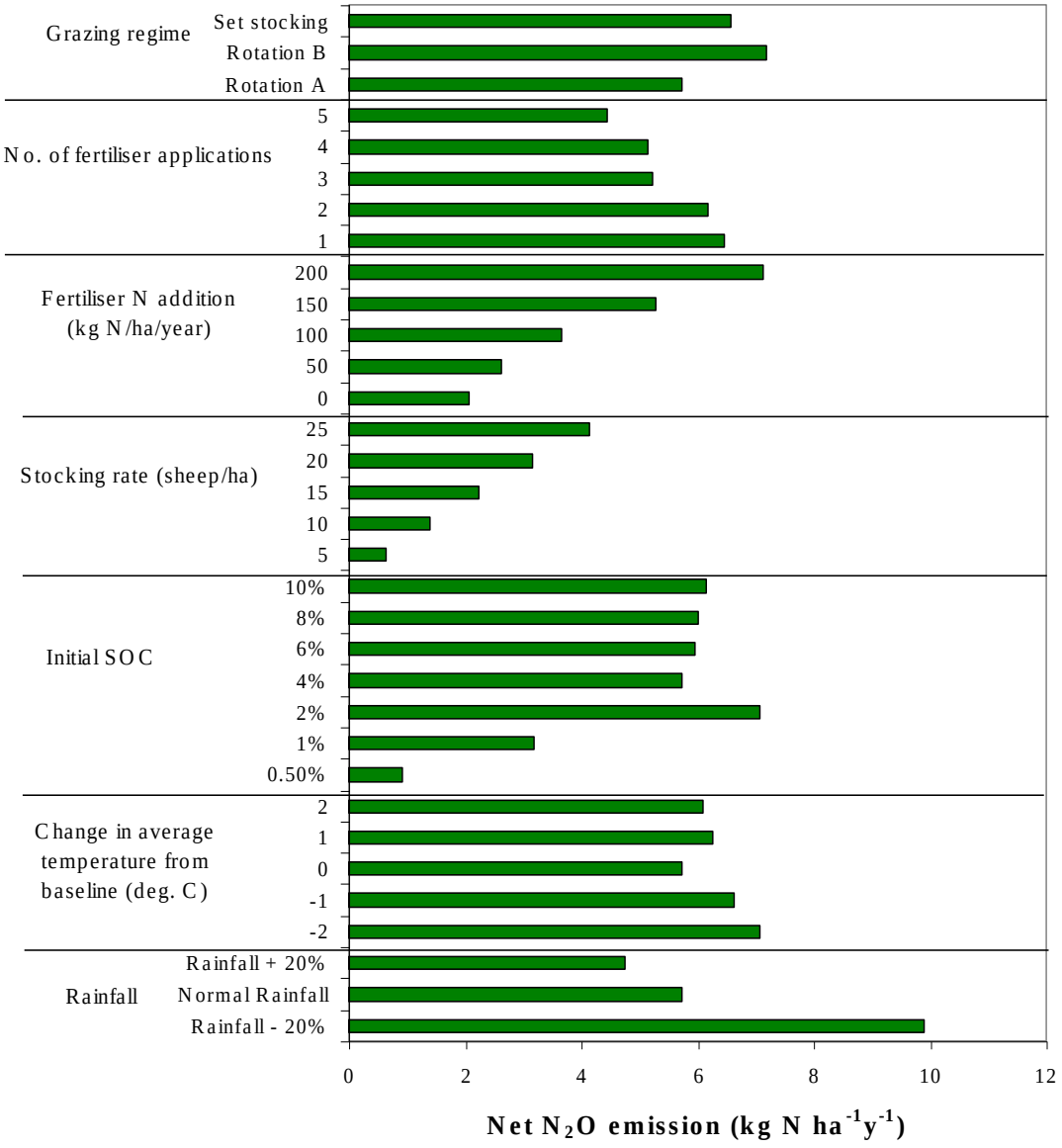




Measured & modelled N_2O emissions



Sensitivity Tests



Upscaling

Grid input parameters:

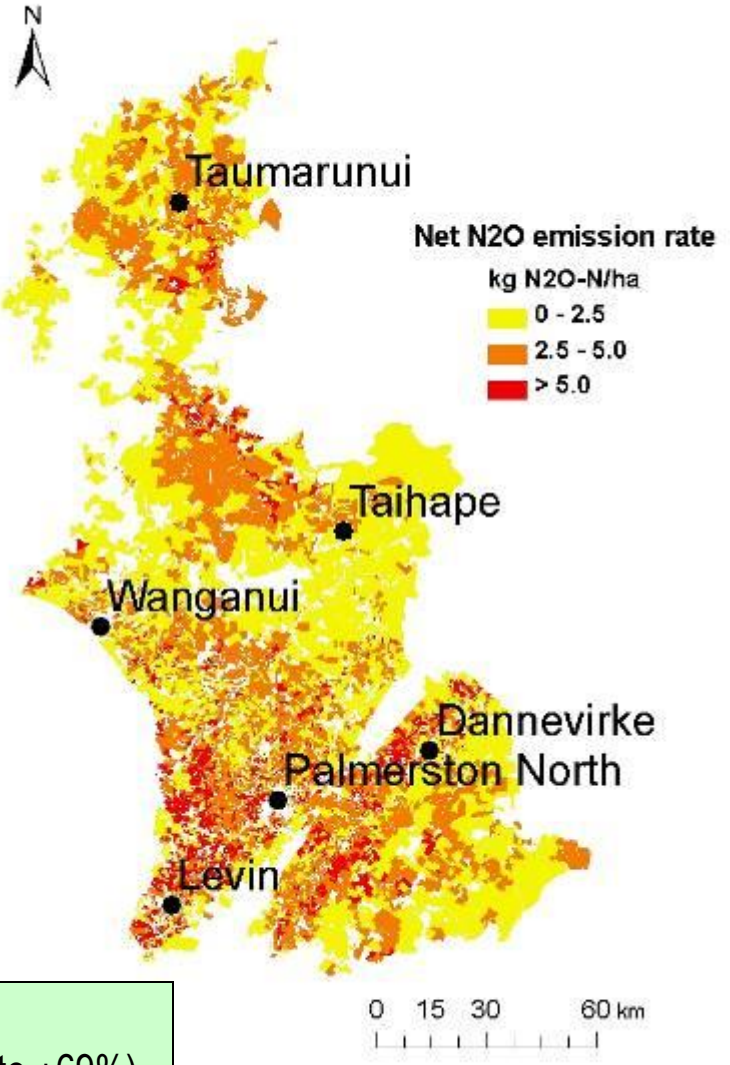
Land use: crop types, acreage, rotation

Soil characteristics: SOC, pH, clay content, bulk density, soil water regimes

Management: fertiliser, irrigation, tillage, grazing

Livestock population including dairy cattle, beef cattle, sheep, deer, pigs, poultry etc.

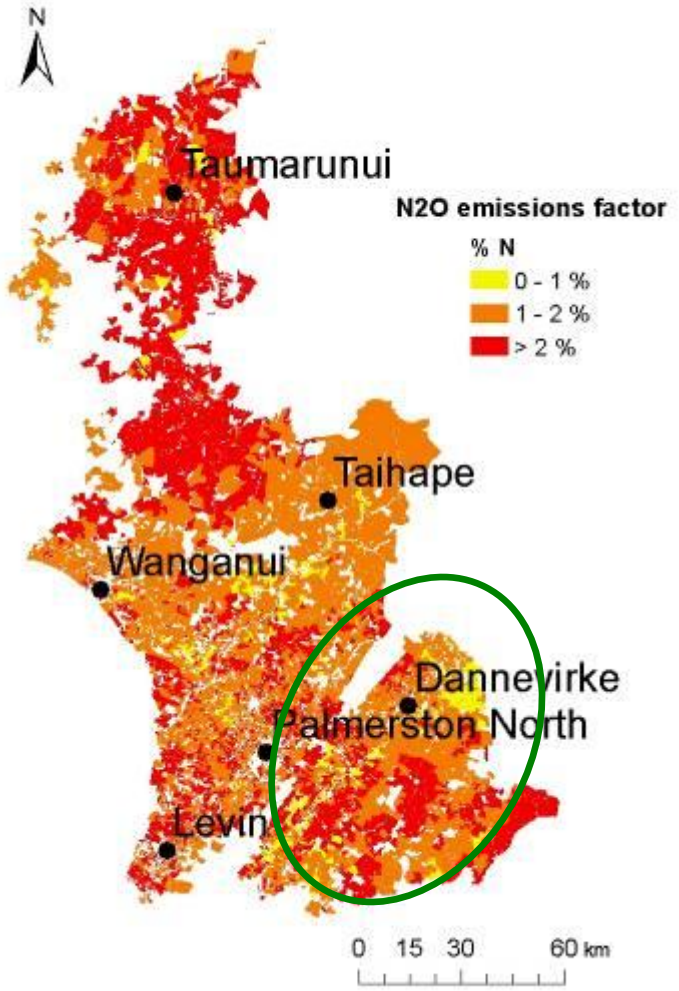
Environmental variables: rainfall, temperature



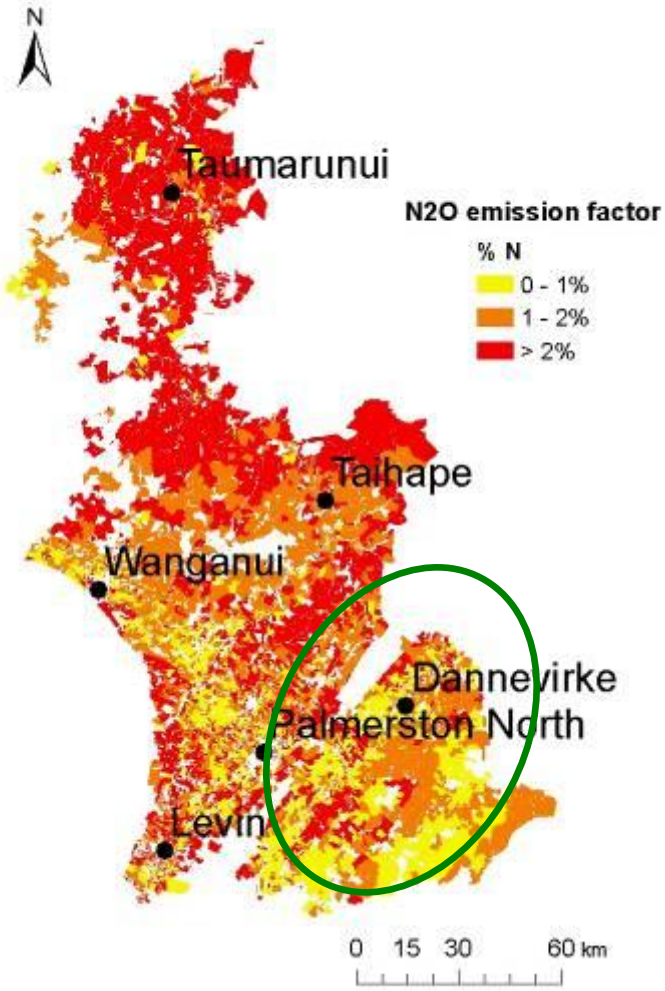
Modeled = 4.2 2.4 Gg
IPCC = 2.29 Gg (-23% to +69%)

Emissions differ between years due to weather effects

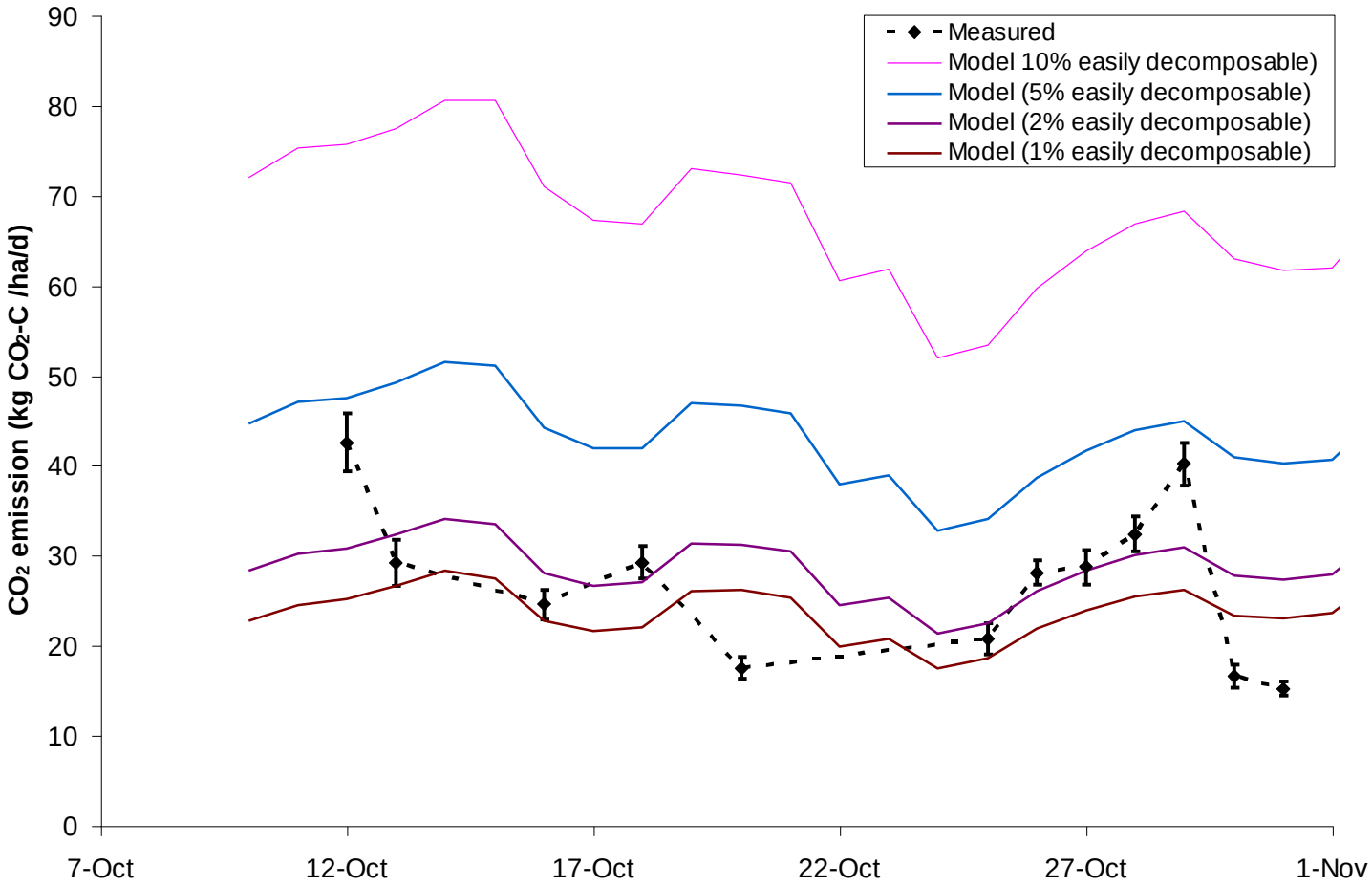
2003



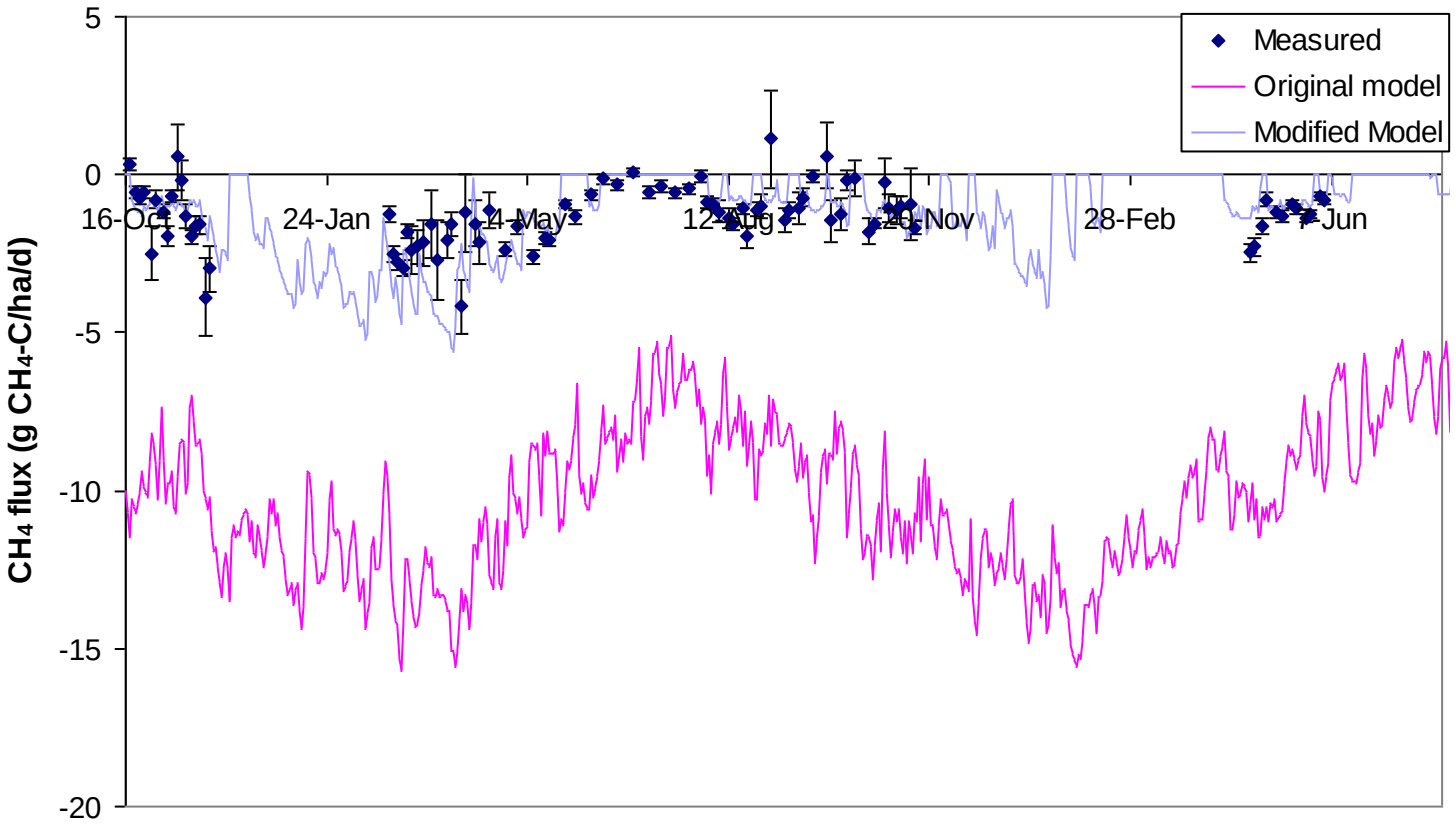
2004



CO_2 emissions



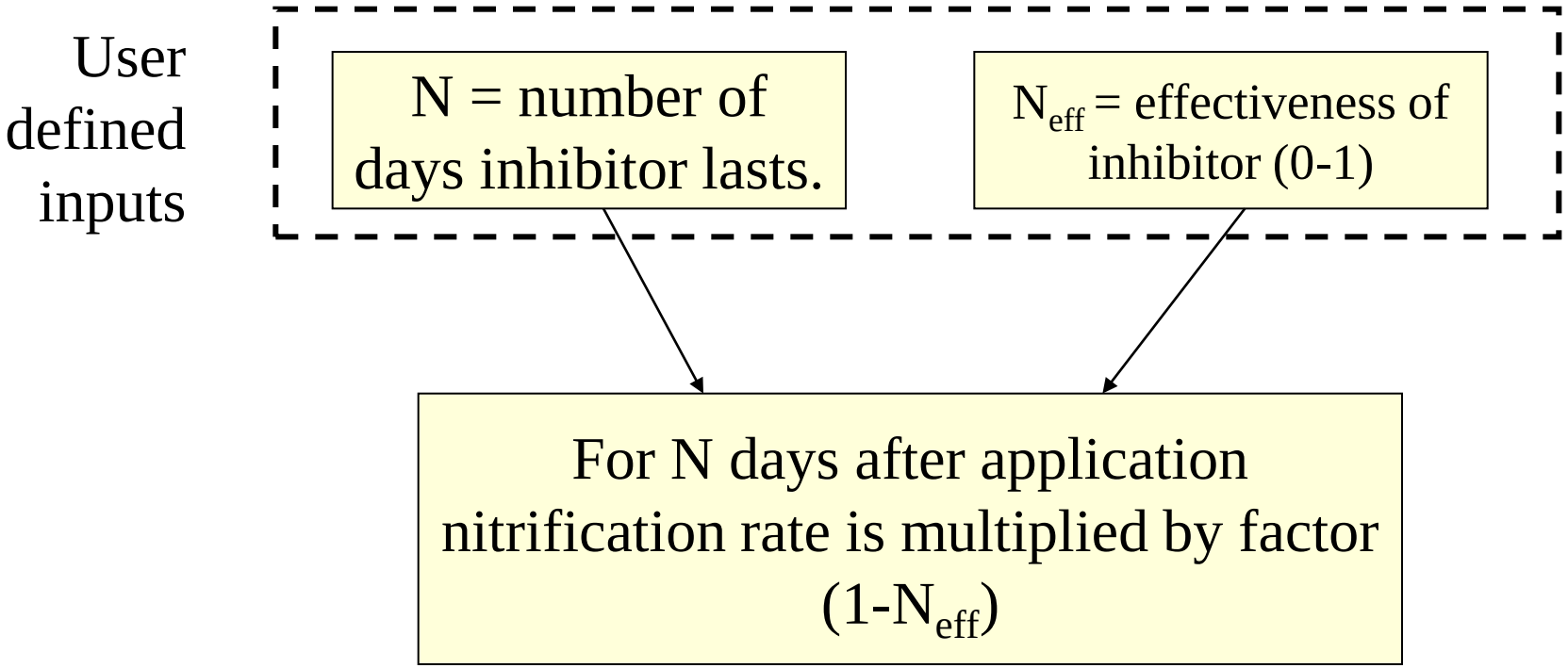
Soil CH_4 uptake



- Modified model to restrict CH_4 oxidation when surface soil saturated

Nitrification Inhibitors

Current NZ-DNDC method for handling NIs



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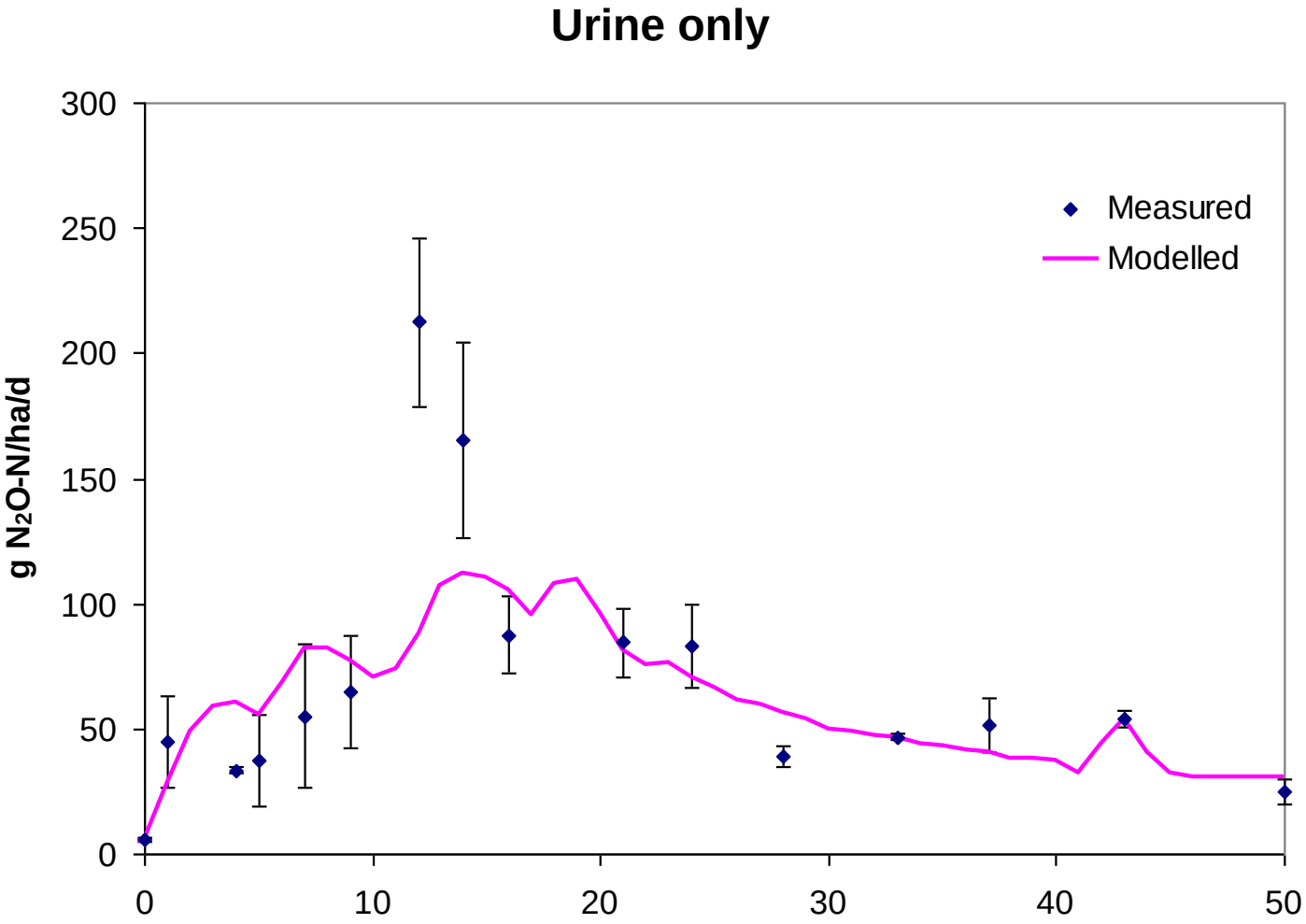

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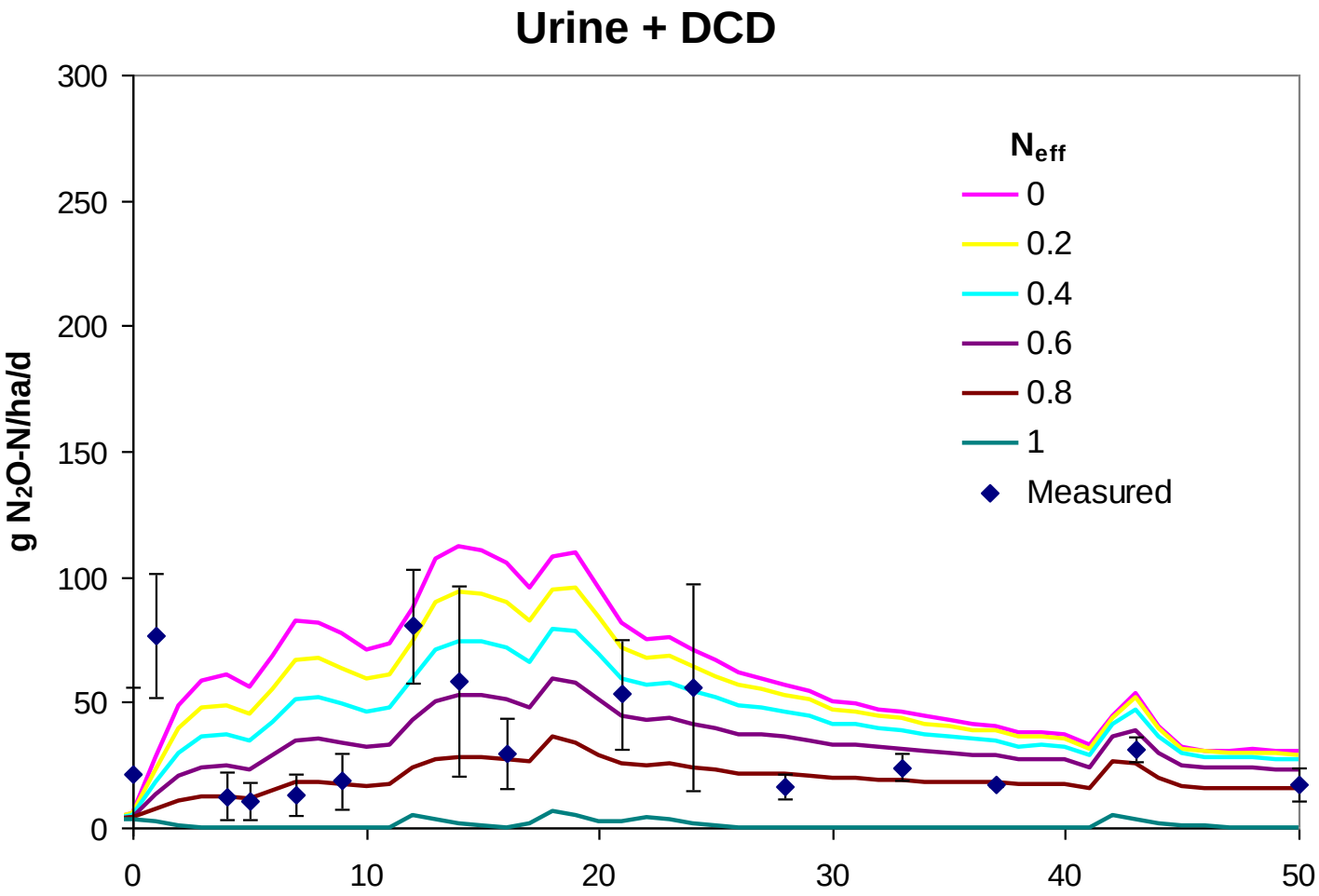

Current Research

- Examine relationship between soil type, nitrification inhibitor effectiveness and decay rate.
- Examine NH_3 volatilisation and soil N transformations.
- Effect of patchiness of excretal urine

References

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