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Manaaki Whenua

Massey University

Development & Evaluation of DNDC:

New Zealand as case study

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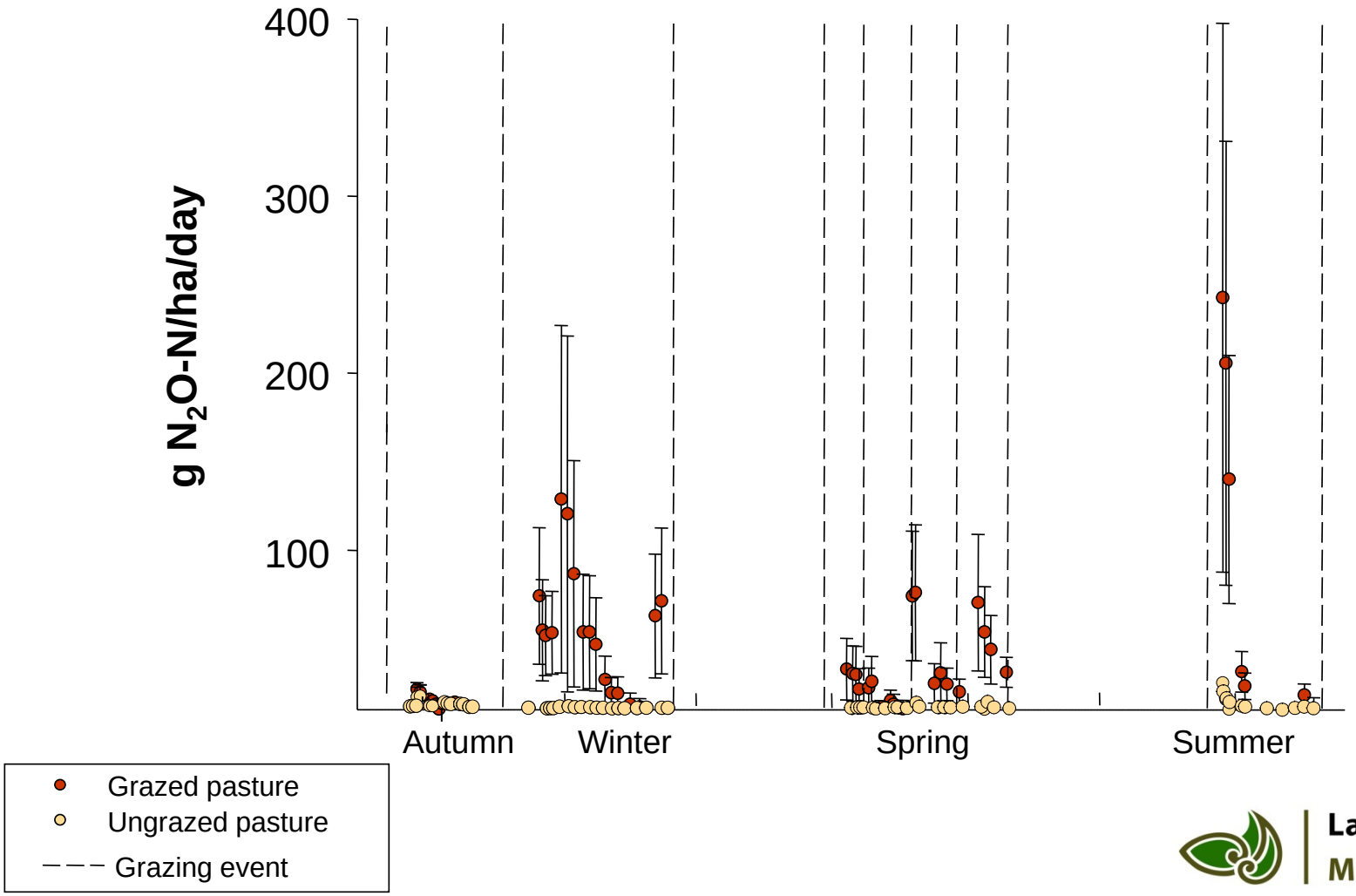
Emissions are spatially and temporally variable



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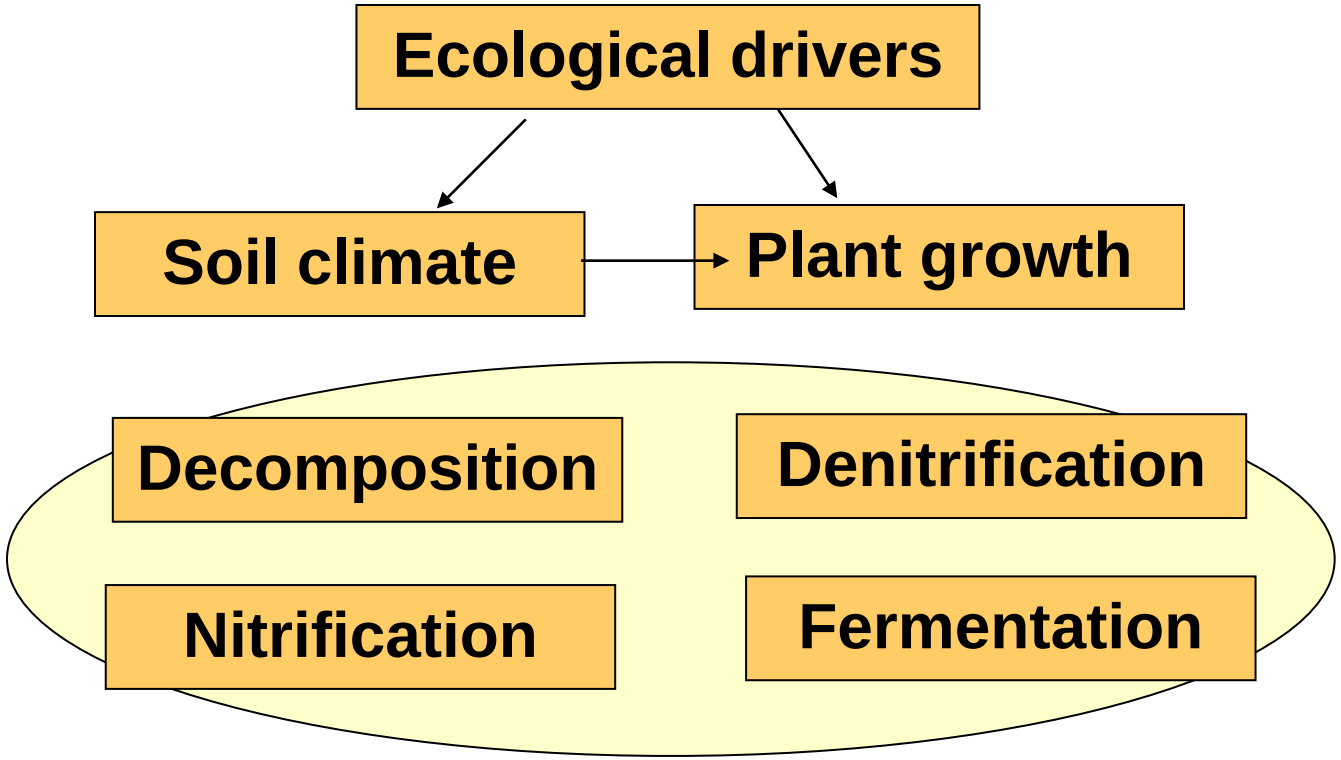
DNDC: A process-based model



- Has since been developed and used for a number of different systems (rice cultivation, grazed pastures, forests, livestock manure management) and countries (including New Zealand, US, Australia, India, China, EU, Canada,…)

Areas vital for model performance

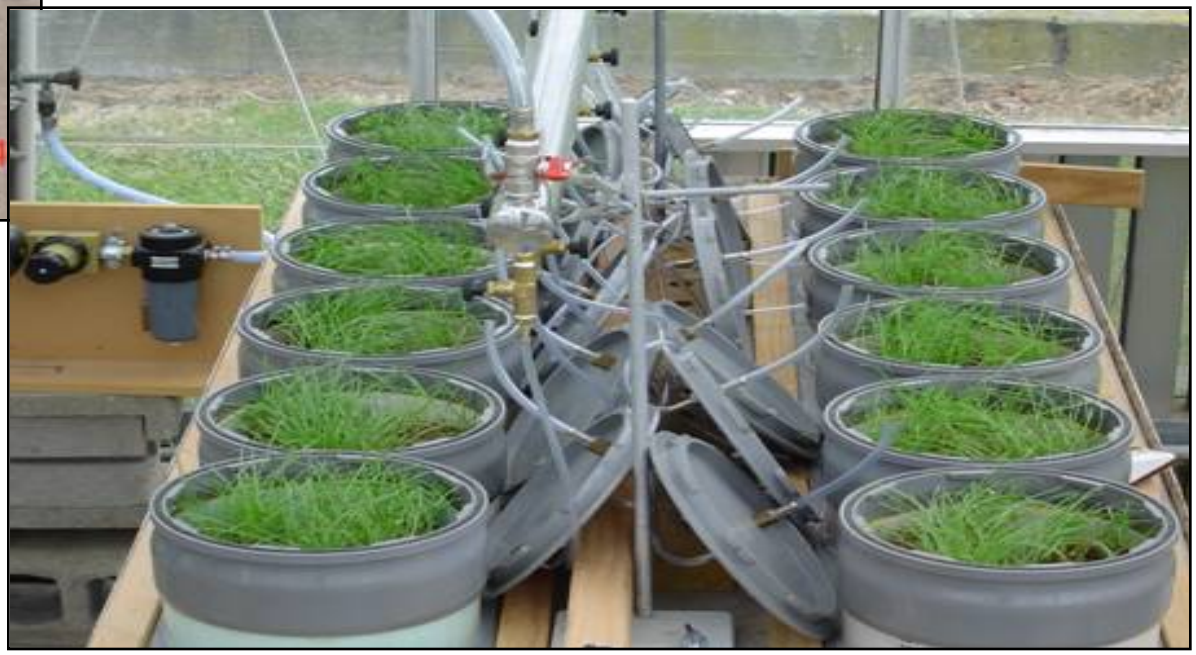
- Adequacy of incorporated process
- Correct parameterisation of the quantitative relationships between he process and their drivers
- Sufficiency and accuracy of model input data

Li (2009)

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

Understanding the key processes regulating emissions



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Assessing small scale field variability in fluxes

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Field measurements

Areas vital for model performance

- Adequacy of incorporated process

  (cropping/pasture growth)
- Correct parameterization of quantitative relationships between the process and their drivers

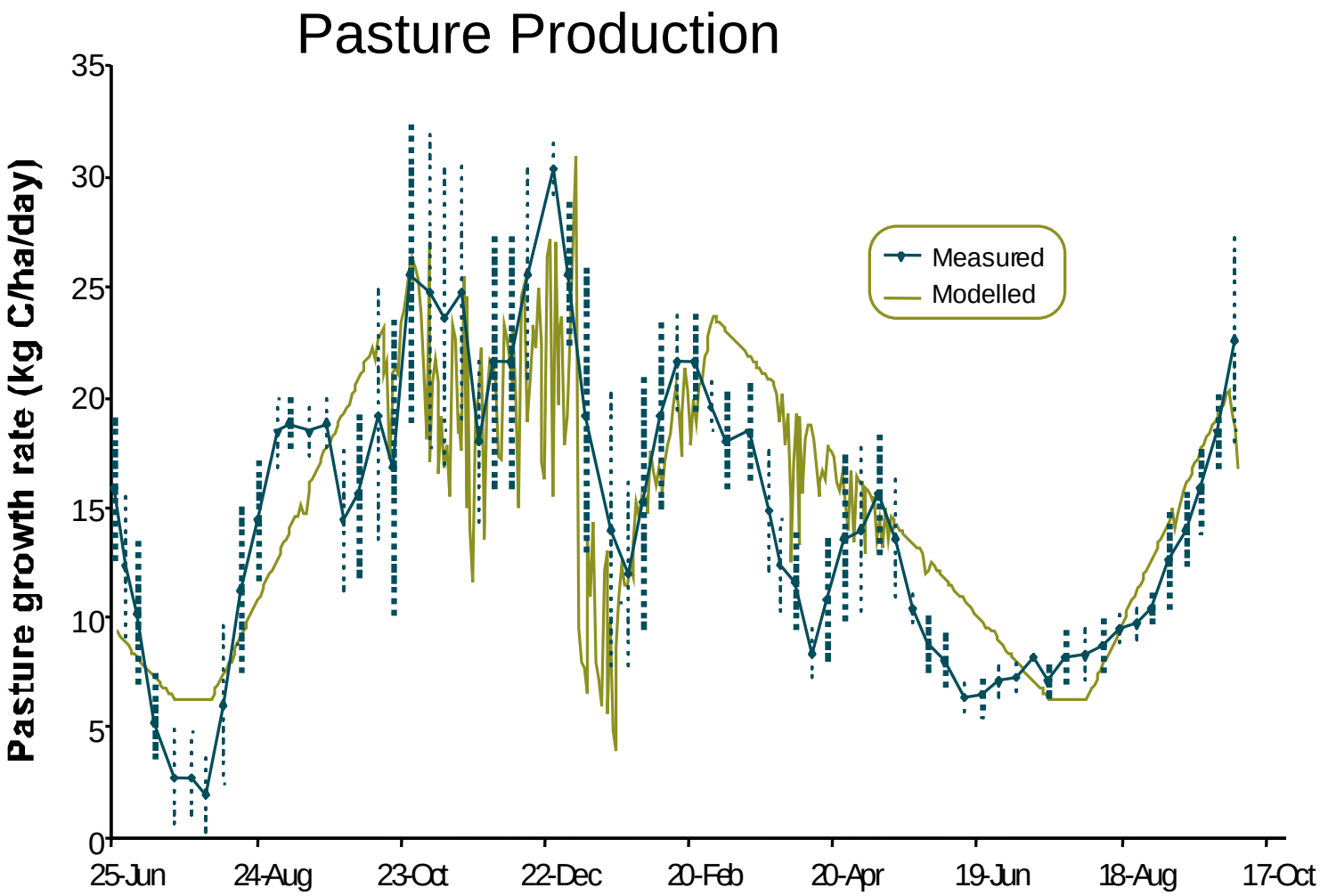
  (grazing- N intake and deposition)
- Sufficiency and accuracy of model input data

  (incorrect WFPS threshold for the onset of denitrification)

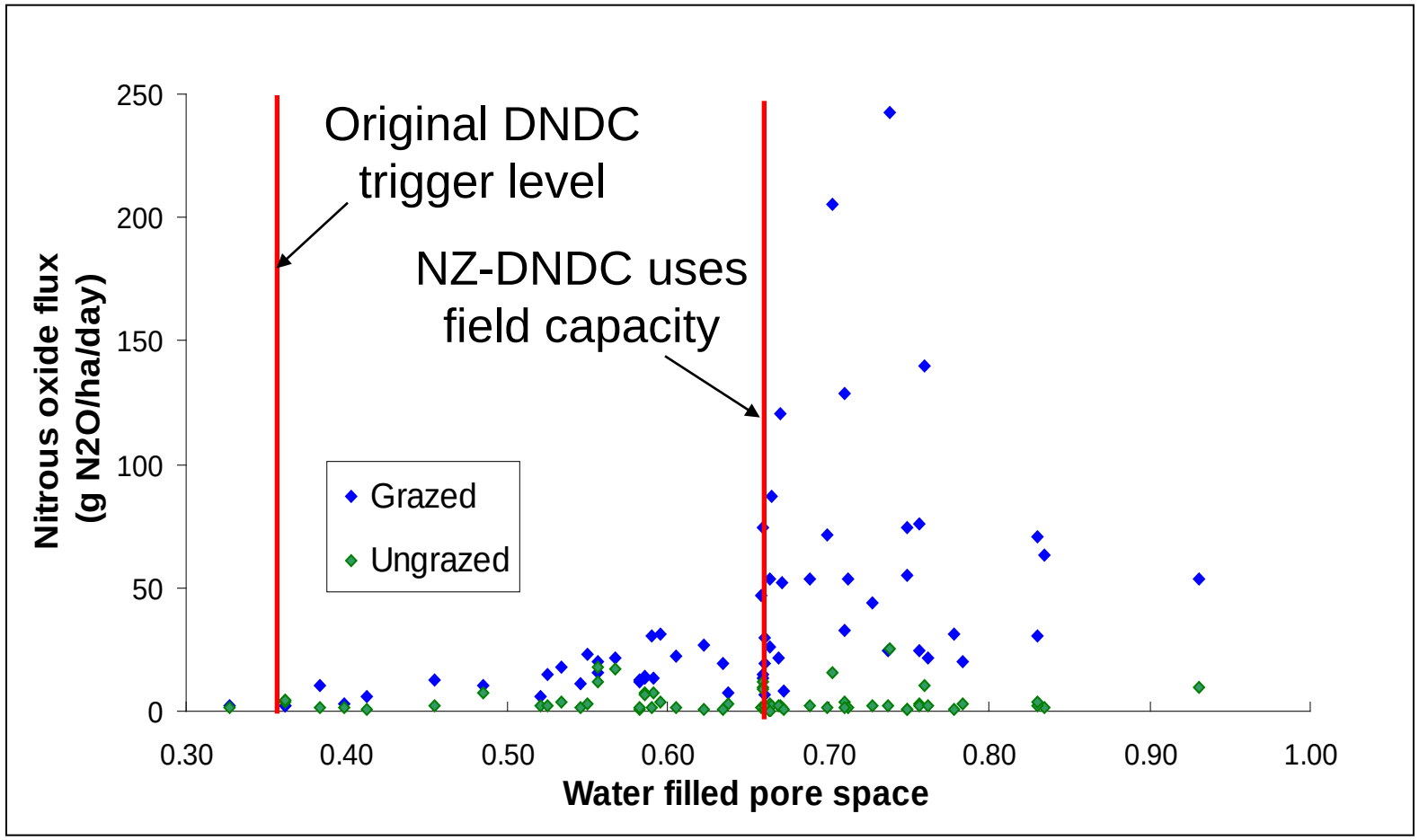
Modifications to ‘NZ-DNDC’

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

Measured and modeled pasture growth

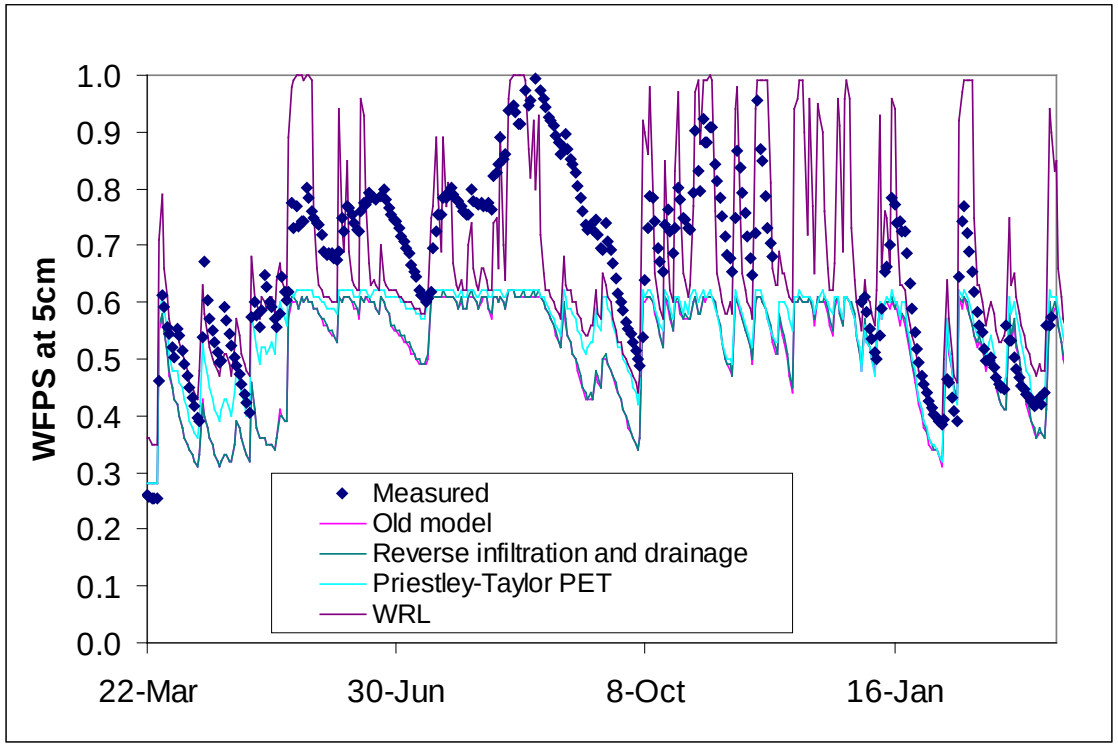


Modifications: Denitrification trigger*



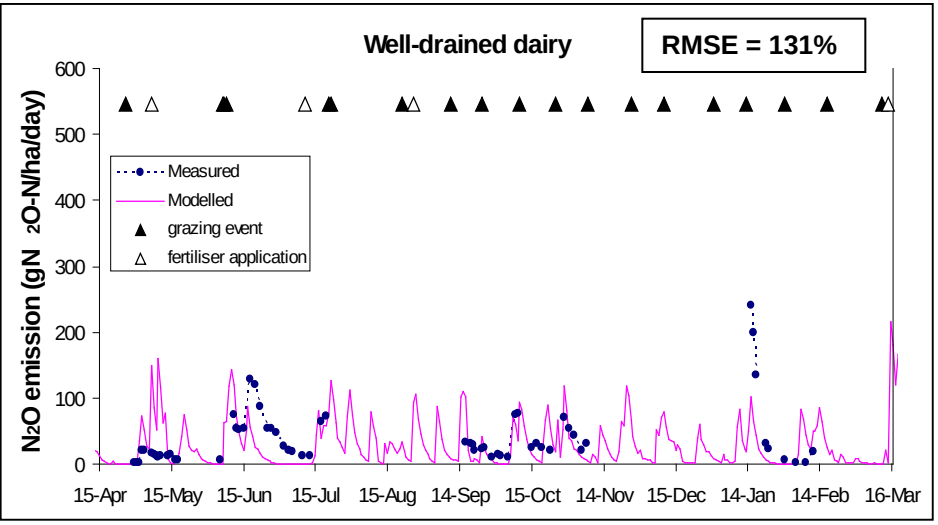
*This has since been superceded by the "N_2O balloon" method of calculating the soil anaerobic volume fraction

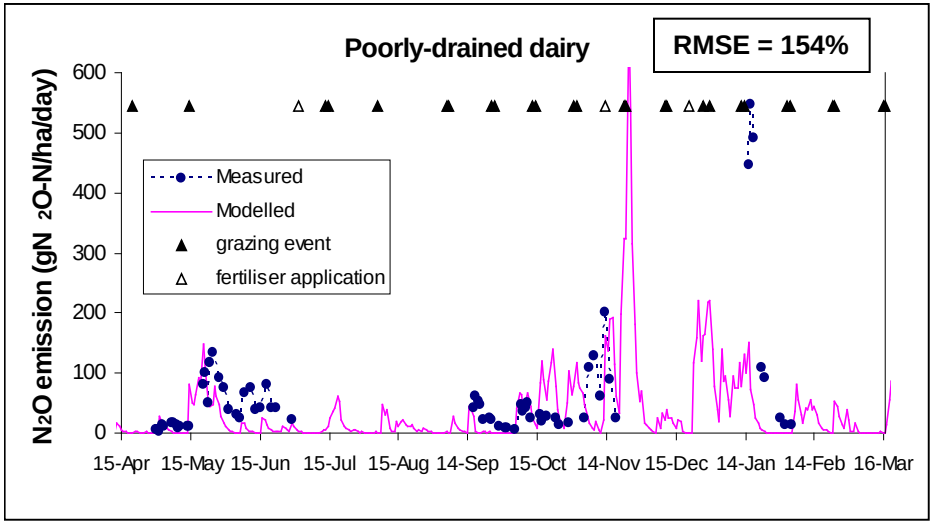
Modifications: Water balance

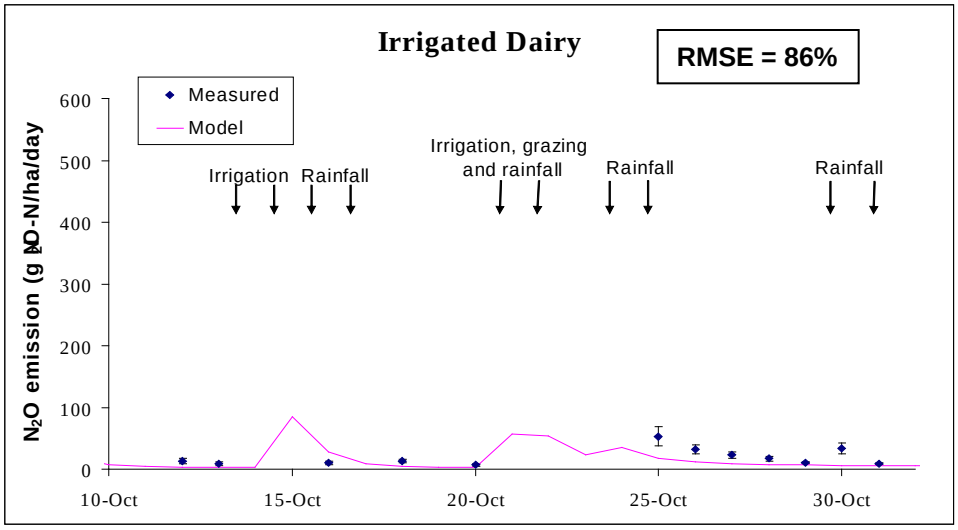


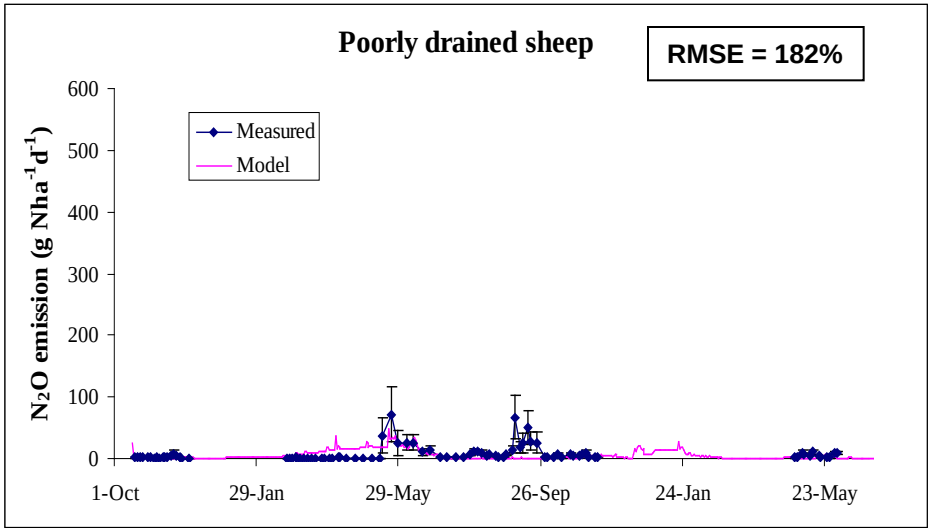
- Reversed the order of infiltration and drainage processes.
- Switched from Thornthwaite to Priestley-Taylor PET equation.
- Added water retention layer

Site level validation

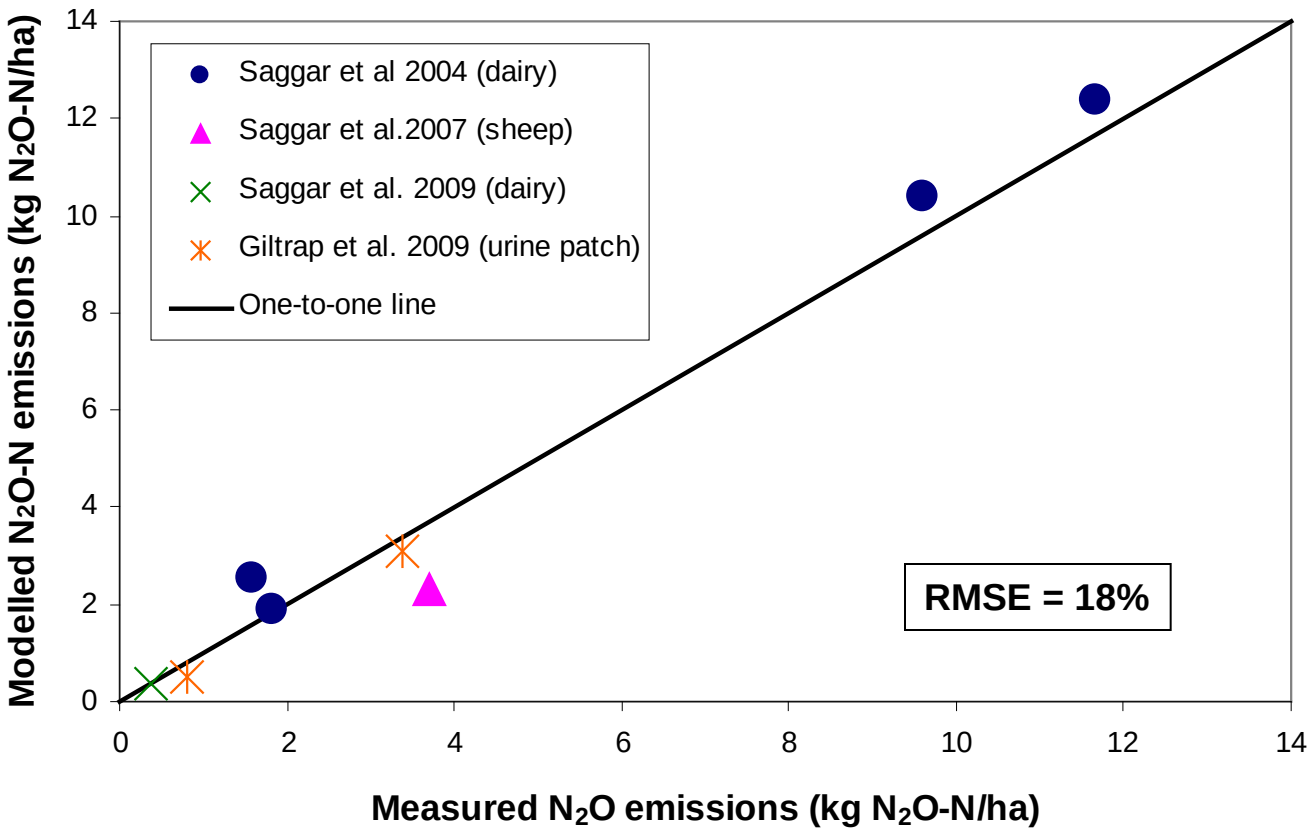




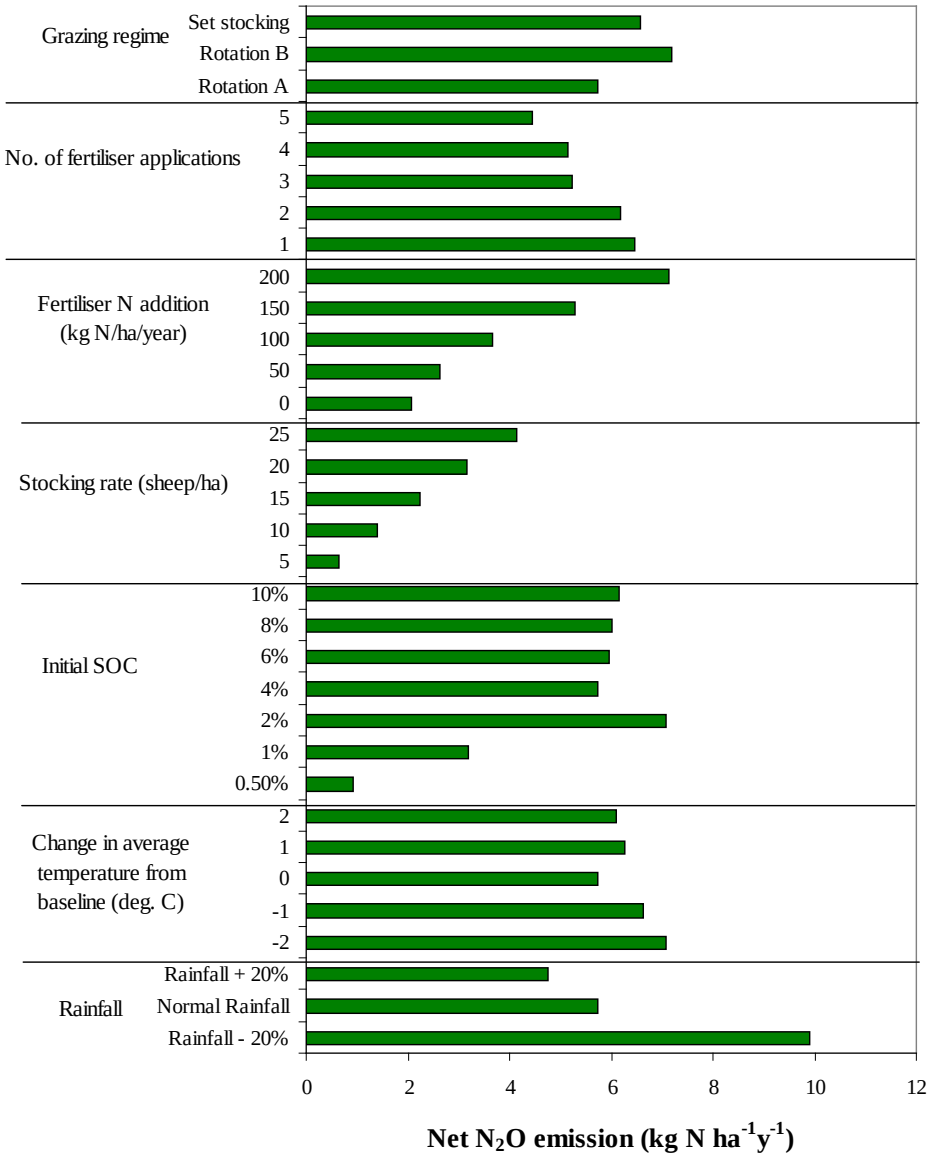




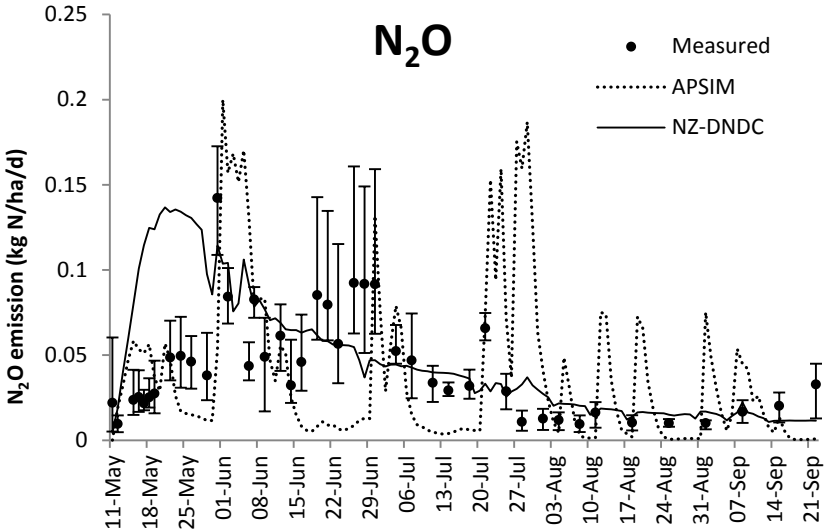
Measured & modeled N_2O emissions

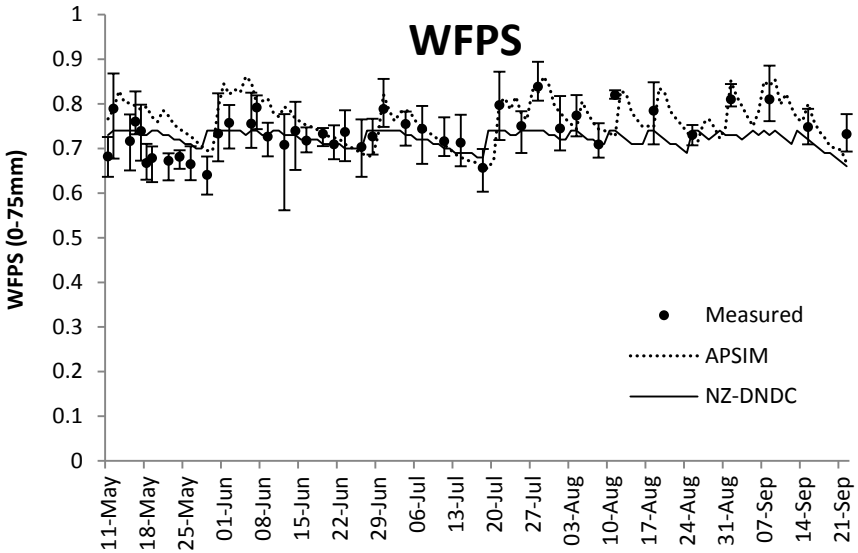


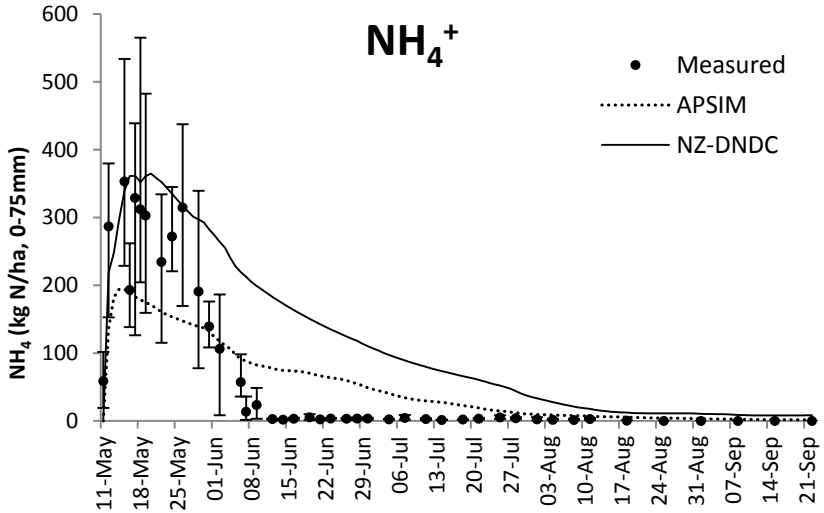
Sensitivity Tests

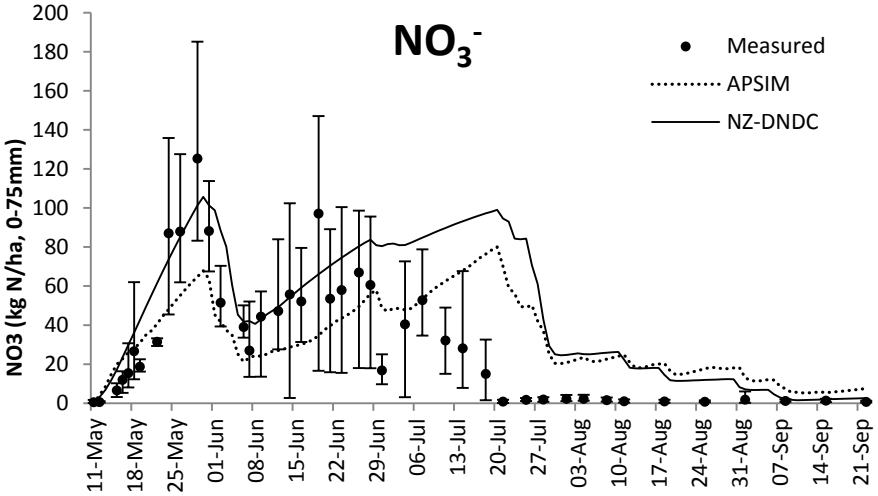


Comparing APSIM & NZ-DNDC









Upscaling

Grid input parameters:

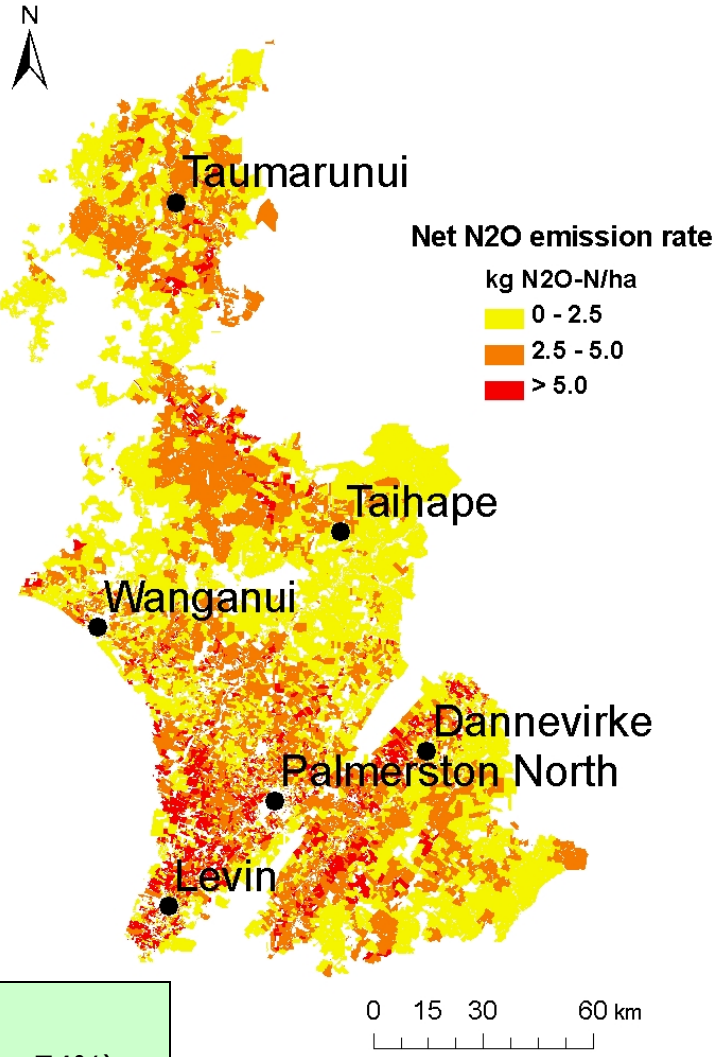
Land use: crop types, acreage, rotation

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.

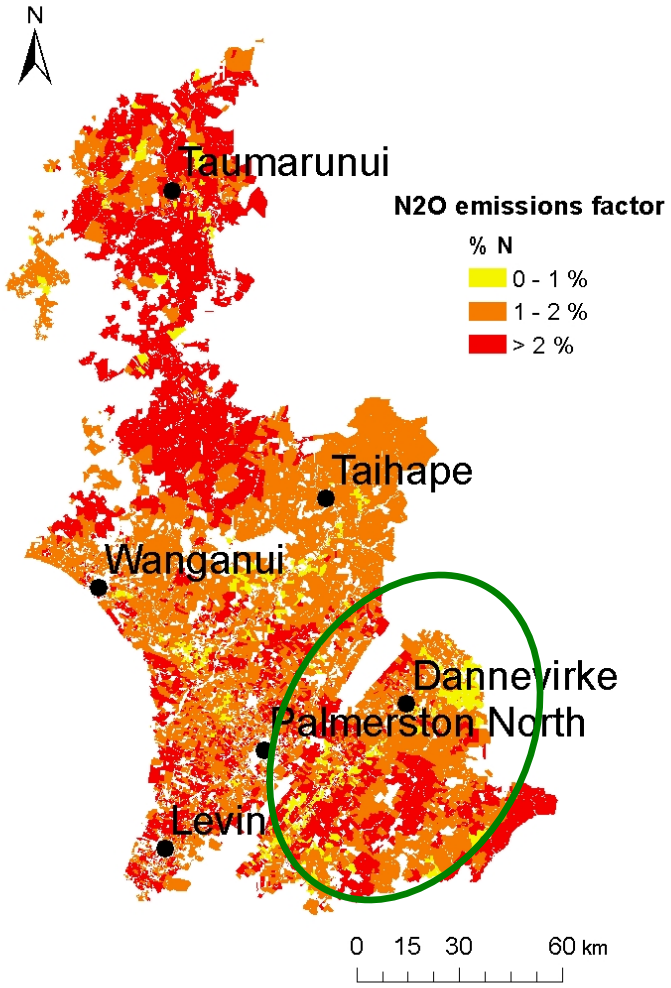
Environmental variables: rainfall, temperature



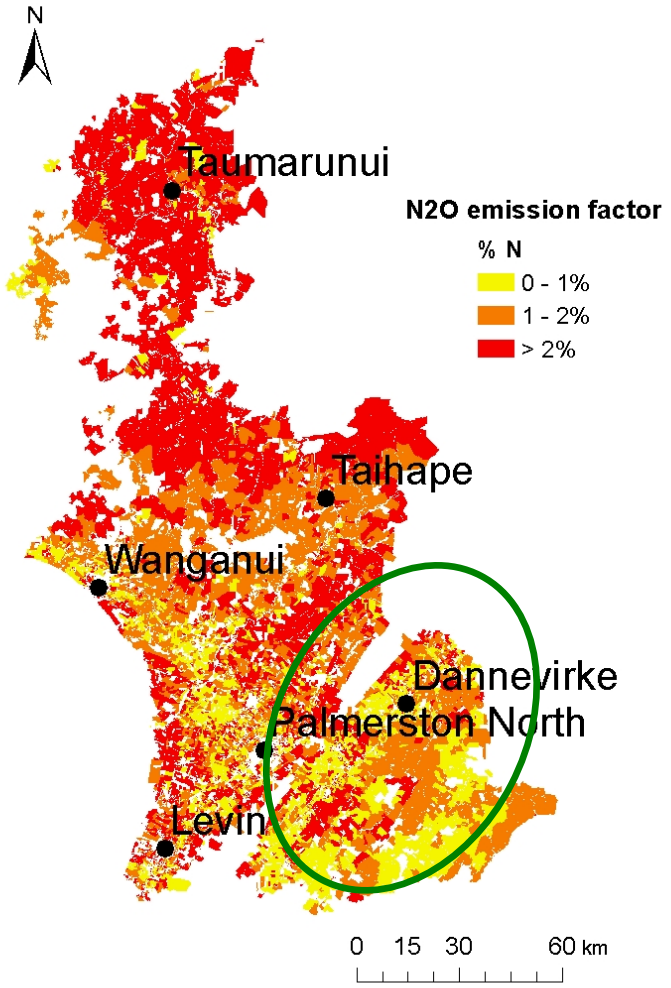
Modeled = 4.4±1.5 Gg
IPCC = 1.6 Gg (-42% to +74%)

Emissions differ between years due to weather effects

2003

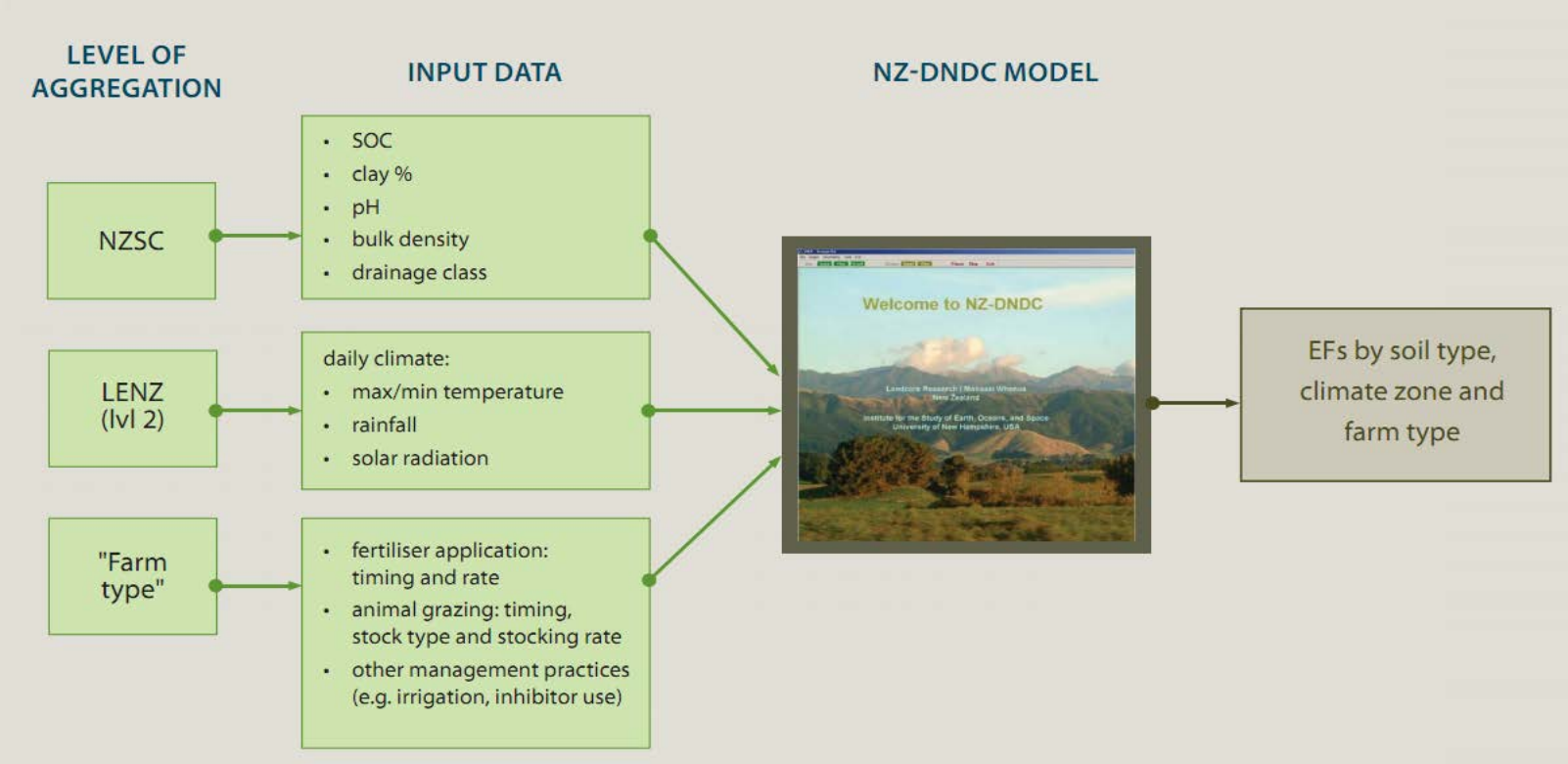


2004



Simple framework for scaling emissions

NZ-DNDC model generates look-up tables of emission factors (with uncertainties) by soil type, climate class and “farm type” (includes management practices)



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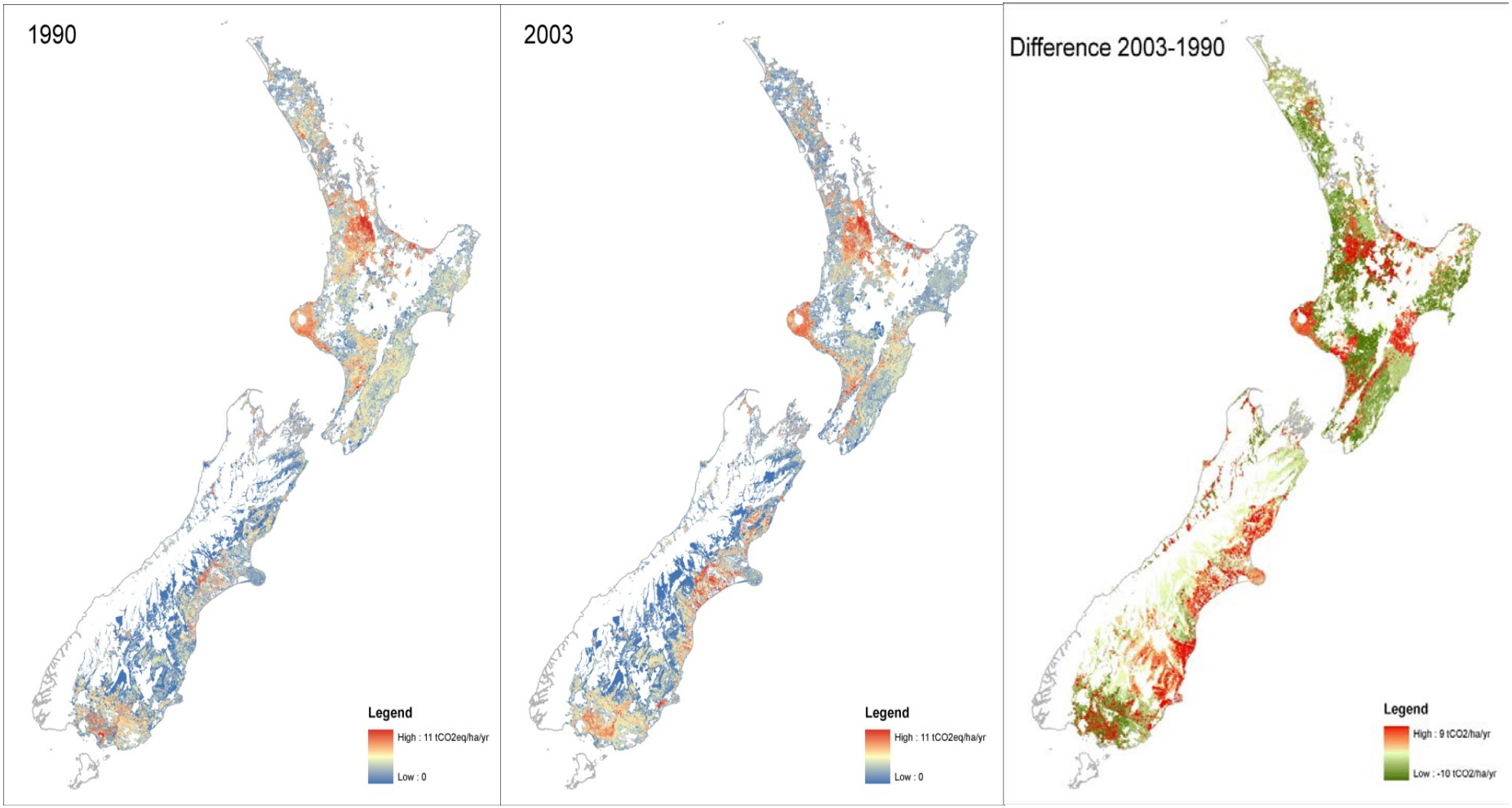
Emission Factor Look-up tables

		Climate B	Climate E	Climate J	Climate Q
BOA	Dairy	0.9%	0.9%	0.8%	0.8%
	SB	0.9%	0.9%	0.7%	0.7%
GOT	Dairy	1.1%	1.0%	0.9%	0.8%
	SB	1.1%	1.0%	0.9%	0.8%
RST	Dairy	2.0%	1.5%	1.8%	1.1%
	SB	2.3%	1.6%	2.0%	1.2%
ZOH	Dairy	1.0%	0.9%	0.7%	0.7%
	SB	0.8%	0.7%	0.6%	0.6%

Simple framework for scaling emissions



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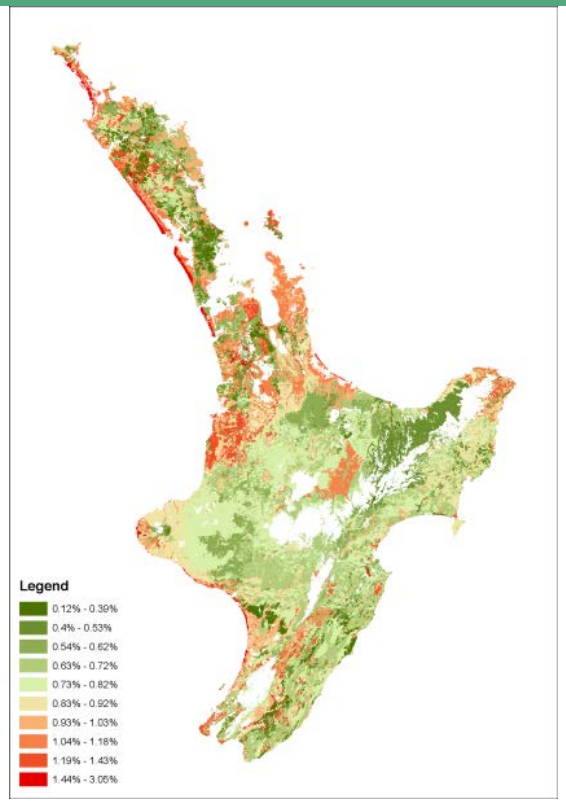
Current Research

- Develop national map of emissions and EFs.
- Examine soil N transformations and gaseous and leaching losses of N under urine patches.
- Determine spatial heterogeneity and uncertainty of N_2O emissions
- Improve pasture production simulations under different grazing regimes
- Assess the impacts of land use change and intensification
- Assess the impact of mitigation strategies to understand trade-offs



(Ongoing): Incorporate new process understanding from experiments into model

Acknowledgments

- ***Our collaborators (national and international research and policy agencies)***
- ***The Post-graduate students***
- ***Our end users (MPI, MfE, DairyNZ, Fonterra, Fertiliser Industries, land-owners)***
- ***Our funders (NZ MSI now MBIE; MPI, MfE; NZAGRC; PGgRc; New Zealand Agricultural Greenhouse Gas Research Centre***

For more information see:
www.landcareresearch.co.nz/science/greenhouse-gases

Mahatma Gandhi

"You must be the change you want to see in the world"

"Whatever you do will be insignificant but it is important you do it"

Thanks for your interest and patient listening