Landcare Research
Manaaki Whenua

NZ-DNDC and OVERSEER® models to estimate nitrous oxide emissions, and the effects of nitrification inhibitors.

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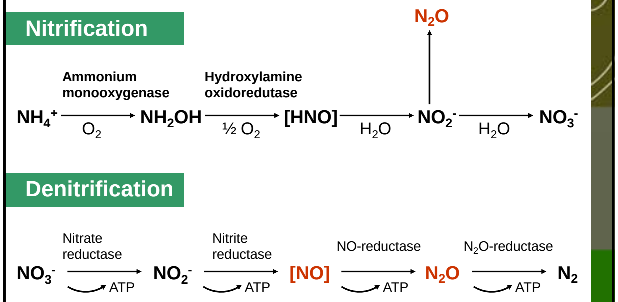
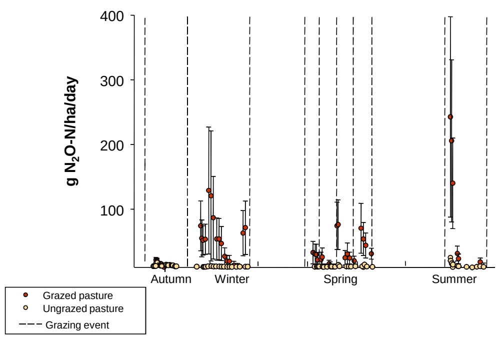
Overview

- emission processes
- why use models?
- OVERSEER and NZ-DNDC models
- comparisons of emissions estimates
- take home messages

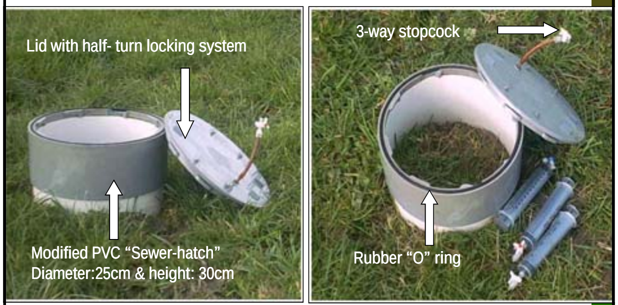
Nitrous oxide emission processes



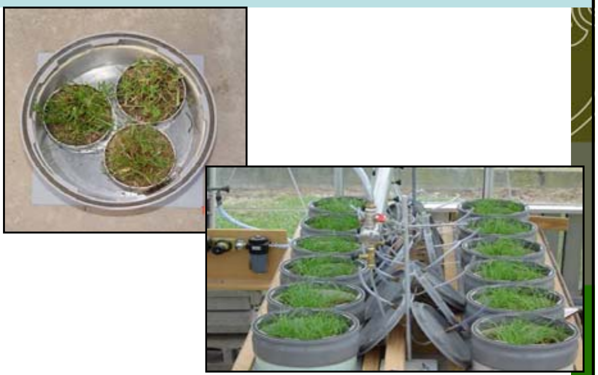
Emissions are spatially and temporally variable



Nitrous oxide emissions measured by Closed Chamber technique

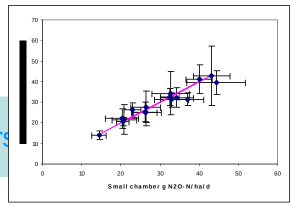


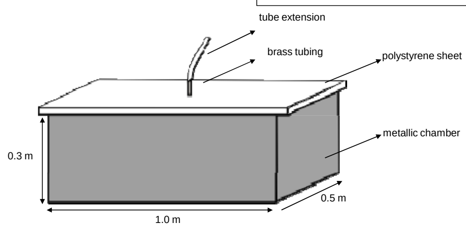
Laboratory measurements



Assessing small scale field variability in nitrous oxide fluxes

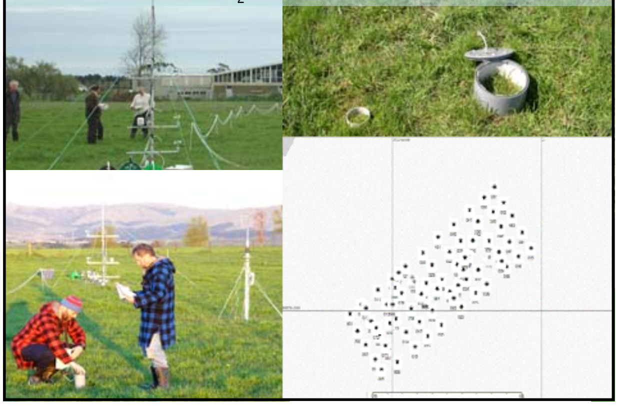
Large and small chambers





Field measurements

Atmospheric gas flux ratio approach and a grid of static chambers for N_2O measurements



Why use models?

- measuring N_2O fluxes accurately from grazed pastures is very challenging
- the high spatial and temporal variability - the largest sources of uncertainty
- the number and frequency of measurements needed make this very difficult to achieve
- an alternative is to use empirical or simulation models that incorporate the major regulatory processes.

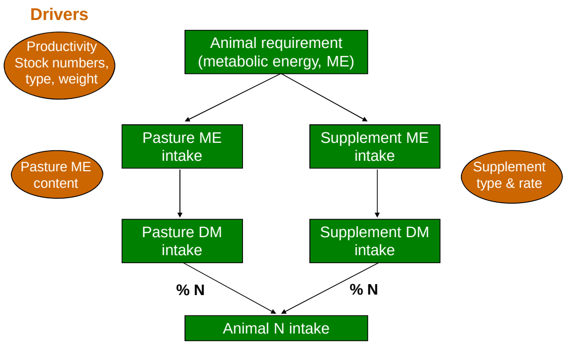
OVERSEER: Nutrient budget model

A decision support software

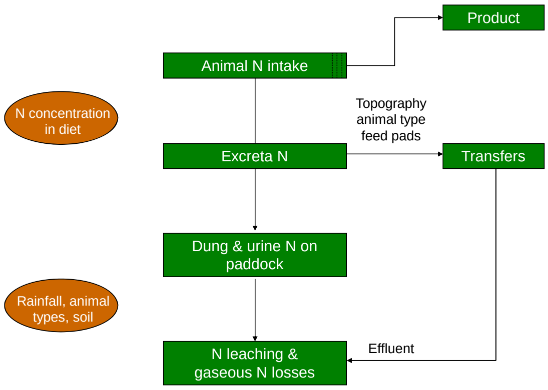
- for maintenance nutrient and lime requirements
- nutrient use efficiency
- environmental effects
- also provides greenhouse gas emissions estimates

Uses farm-friendly inputs

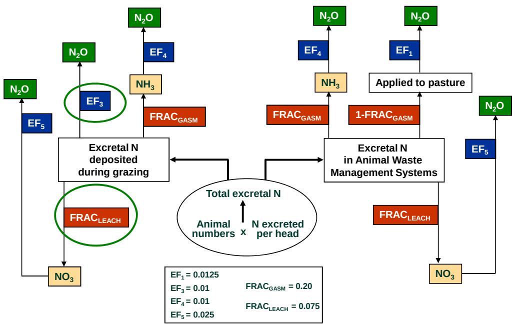
OVERSEER: Animal intake sub model



OVERSEER: Nutrient loss sub model



OVERSSER : emission estimates

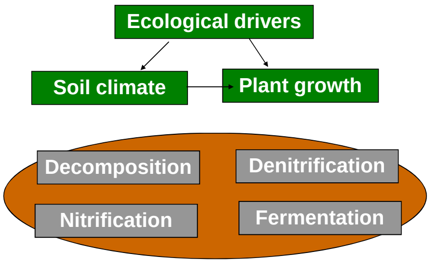


DNDC: A process-based model

- DNDC (Denitrification-Decomposition) simultaneously simulates the production of N_2O, CO_2 and CH_4 from agricultural soils.
- has been adapted for use on grazed pastoral systems (NZ-DNDC)
- has been up scaled to region
- has the potential to assess the efficacy of mitigation strategies for N_2O emissions

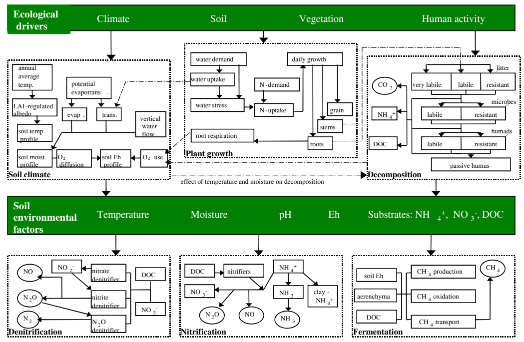
Uses soil, plant, animal and climatic inputs

DNDC: A process-based model

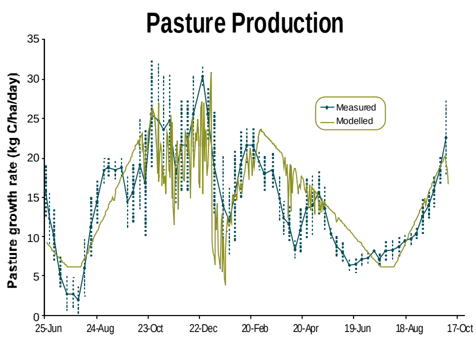


- Produced robust estimates for the US, China, Canada, Japan, India and the UK.
- Has been modified and tested for New Zealand's grazed pasture systems (NZ-DNDC)

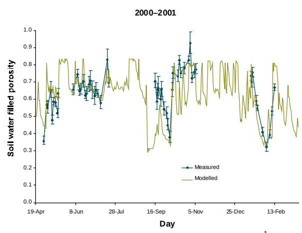
DNDC: A process-based model

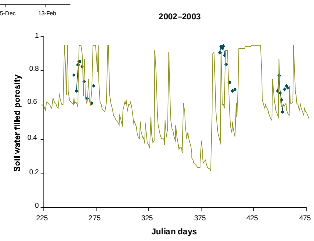


Measured and modelled pasture growth

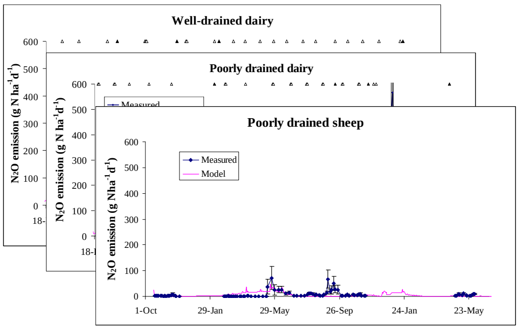


Measured vs. Modelled WFPS





Site level validation



Soil nitrous oxide emissions by land use

Land use	Annual N_2O emissions (kg N_2O-N ha^{-1}) Measured	Modeled
Dairy-grazed	8.6 – 14.7	11.9 – 14.3
Beef-grazed	n/a	6.5 – 9.3
Sheep-grazed	3.7 – 6.5	5.5 – 6.1
Deer-grazed	n/a	4.9 – 7.4
Un-grazed	0.9 – 2.8	1.9 – 3.0
Cropping	2.3 – 3.2 (seasonal)	6.0 – 7.4
Pine	0.6	n/a

Upscaling

Grid input parameters:

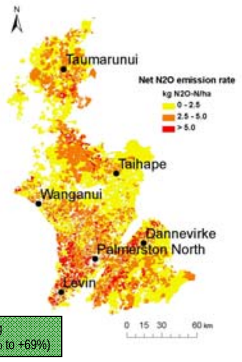
Land use: crop types, acreage, rotation

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

Management: fertiliser, irrigation, tillage, grazing

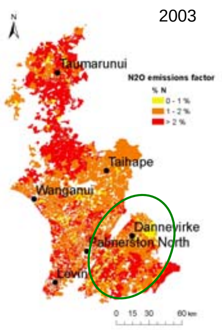
Livestock population including dairy cattle, beef cattle, sheep, deer, pigs, poultry etc.

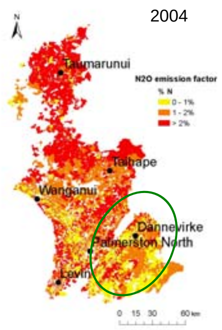
Environmental variables: rainfall, temperature



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

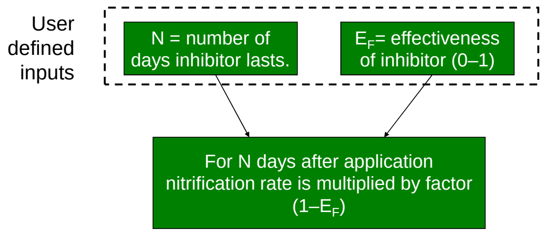
Emissions differ between years due to weather effects



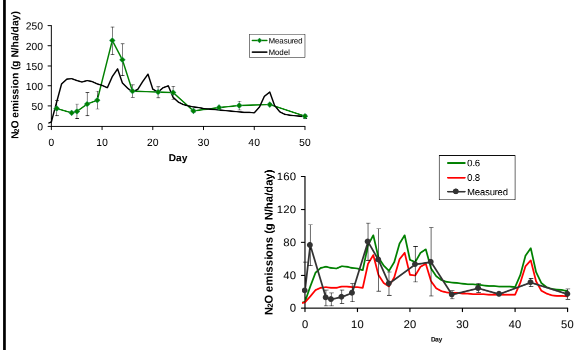


Modelling mitigation of N_2O

Current NZ-DNDC method for handling NIs



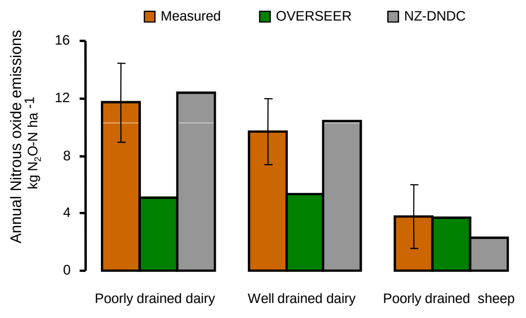
Modelling mitigation of N_2O



NZ-DNDC vs. OVERSEER

	NZ-DNDC	Overseer
Output data	Daily and Annual	Long-term annual average
Scale	Paddock, Region, Nation	Farm
Current users	International Researchers	NZ only Farmers
Published model	Yes	No
Free availability	Yes (DNDC)	Yes
N_2O emission	Process-based	IPCC default method
NO_3^- leaching	Yes	Yes
Nitrification inhibitors	Yes	Yes
Soil CH_4 and CO_2 fluxes	Yes	No
Enteric methane	No	Yes
Estimated farm energy use	No	Yes
Nutrient budgets	No	Yes
Uncertainty	Can be estimated	More difficult to determine

Measured & modeled N_2O emissions



Take home messages

- emissions change with changes in soil moisture resulting from rainfall and/or irrigation
- emissions vary with soil types, timings of fertilisation and grazing events/regimes
- emissions increase with increasing soil compaction, C levels, stock numbers and levels of fertiliser application
- emission Factors (EFs) are different for dairy- and sheep-grazed systems.
- OVERSEER approximates farm scale emission estimates
- NZ-DNDC offers a way forward for the development of regional and national emissions inventories, and assessing mitigation strategies.

Acknowledgements

- Our national and international research and policy collaborators
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- New Zealand Foundation for Research, Science and Technology