Using POAMA for reducing N_2O emissions in subtropical dairy systems

Lessons from a modelling approach using DayCent

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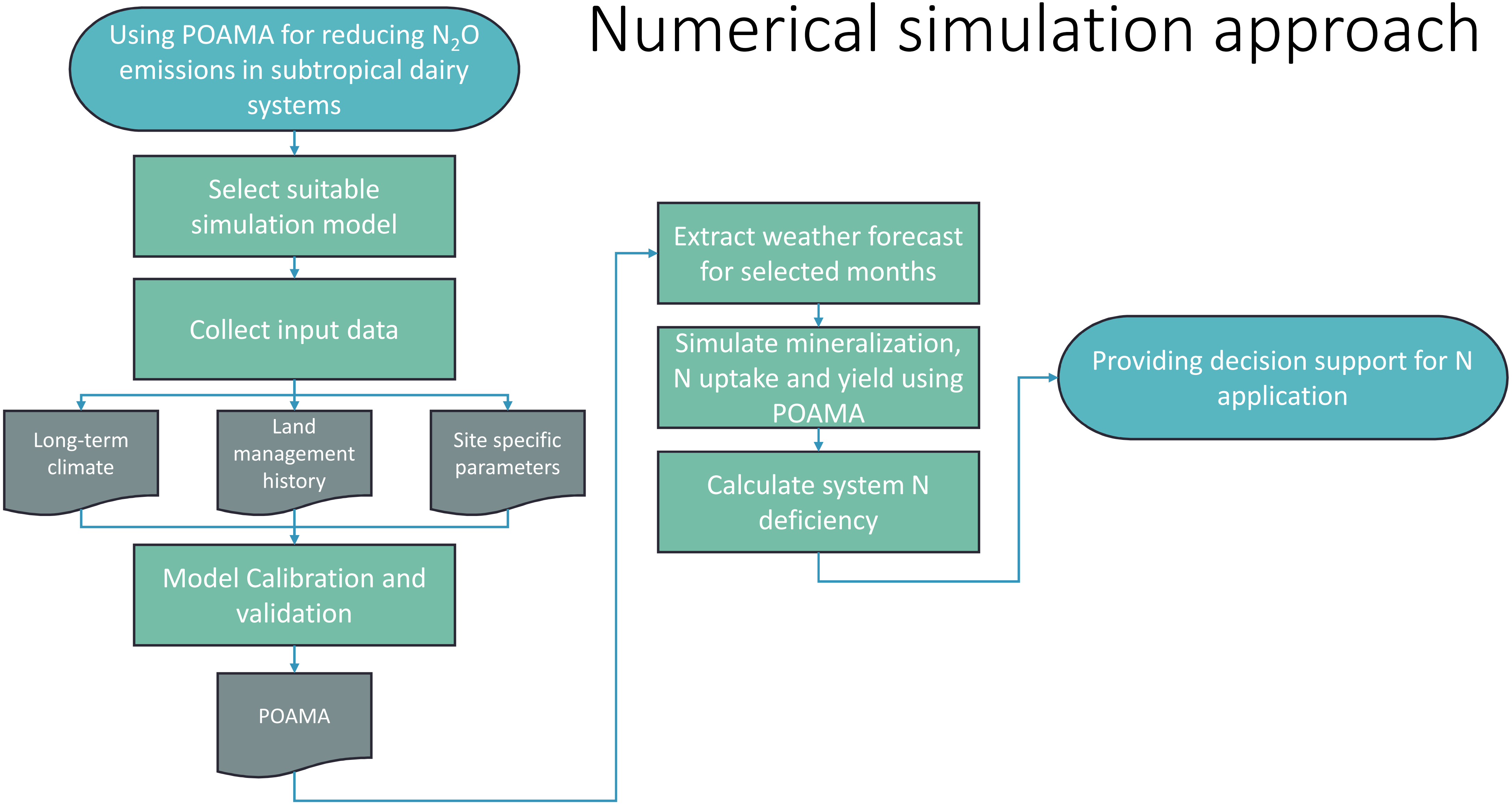
Mid-range climate forecasts

- POAMA: Predictive Ocean Atmosphere Model for Australia.
- Bureau of Meteorology's dynamical (as opposed to statistical) climate model used for multi-week to seasonal through to inter-annual climate outlooks
- outlooks 1-9 months ahead.
- twice weekly forecasts consisting of 33 scenarios. The variability of the results among the 33 runs gives an indication of the uncertainty in the future evolution of the climate system.
- Hindcasts available

Numerical simulation approach



Case study site

- 11 km east of Gympie and 180 km north of Brisbane
- Rye Grass/ Kikuyu
- Farmer owned/operated property
  - 240 milking cows
- Red dermosol
  - 0-25 cm: Clay loam
  - 25 cm+: Clay
- 4.7% Carbon (0-10cm)
- pH 6.0 (0-10cm)
- site rainfall 1000 - 1250 mm
  - 1st Jan 2012; 1200 mm

Treatments: Fertilser rate & inhibitors

Two years of field measurements: May 2012-April 2014 (NANORP)

- Treatments
  - 0 kg N ha
  - 23 kg N ha (1 kg N ha day)
  - 23 kg N ha applied as ENTEC
  - 45 kg N ha (typical N rate applied in the region; 2 kg N ha day)
  - 45 kg N ha applied as ENTEC
- Greenhouse gases (N_2O, CH_4, CO_2)
- N^{15} subplots (10% enrichment)
  - Added every fertilisation
  - Analysed for recovery in pasture (each grazing)
  - roots and soil (end of fertilisation)
- Pasture biomass production

Selecting numerical simulation model

DairyMod

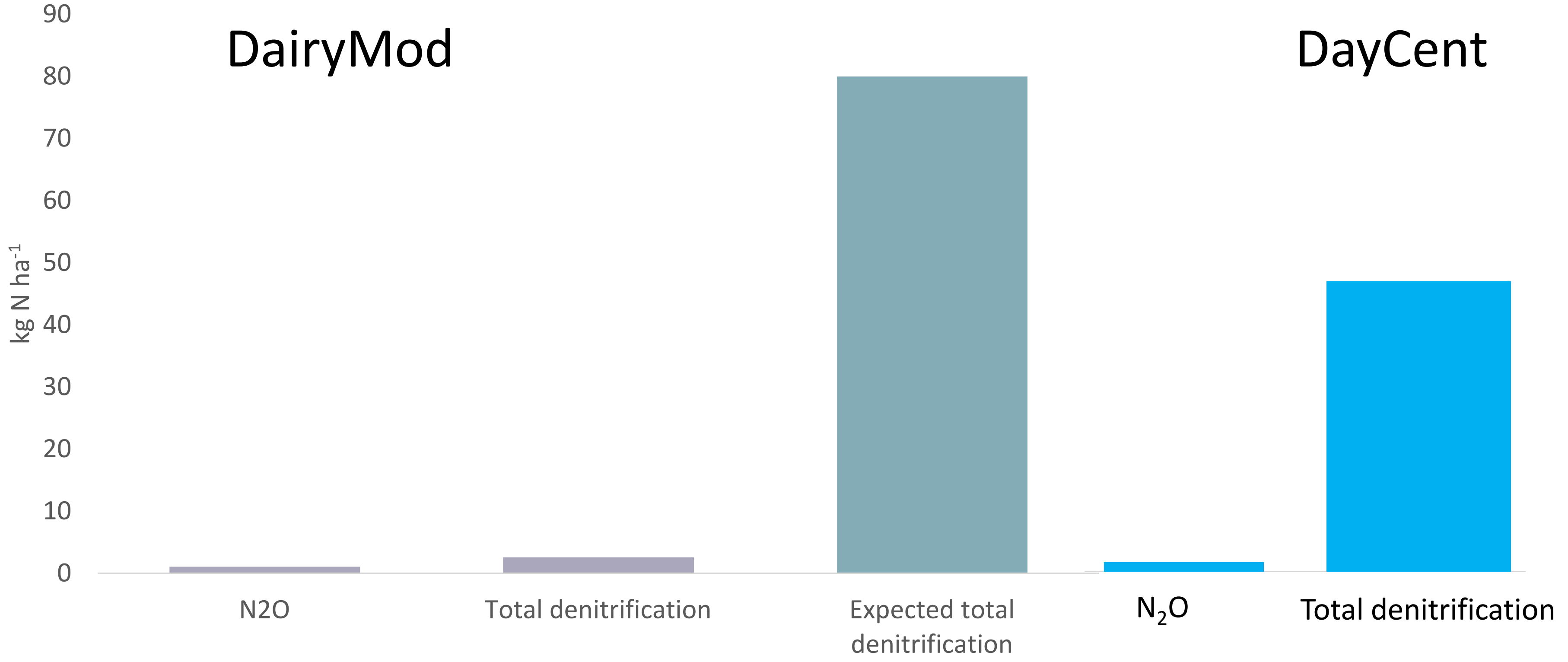
- Multi-paddock, biophysical simulation model

DayCent

- Daily version of CENTURY
- Biogeochemical simulation model
- Simulates fluxes of C and N between the atmosphere, vegetation and soil

Selecting numerical simulation model

Model performance



Simulated average annual N losses from denitrification and expected total denitrification losses from Gympie for the period 2003 to 2012. Expected losses from Rowlings *et. al.* 2016.

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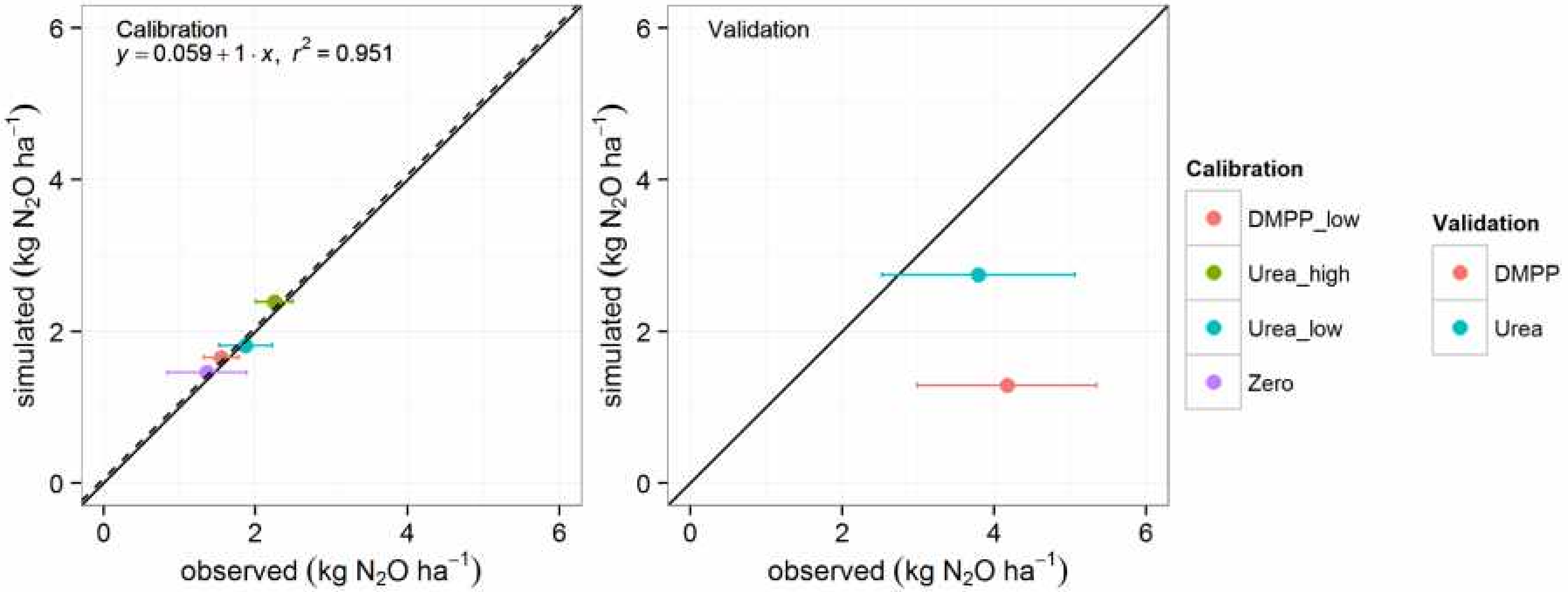
Model calibration and validation: N_2O emissions



Simulated and observed N_2O emissions for Gympie during model calibration (2012-2013) and validation (2013-2014).

Total denitrification losses (44-90kg/ha/year)

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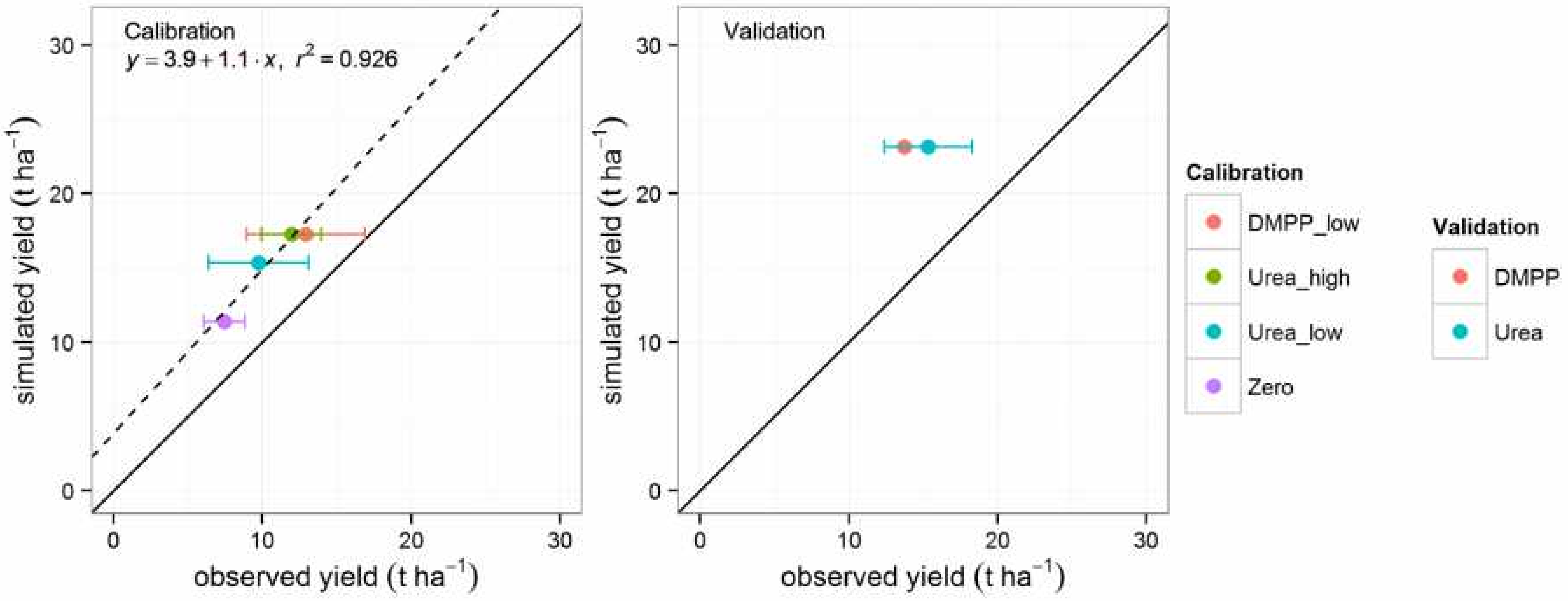
Model calibration and validation: Yield



Simulated and observed biomass production for Gympie during model calibration (2012-2013) and validation (2013-2014).

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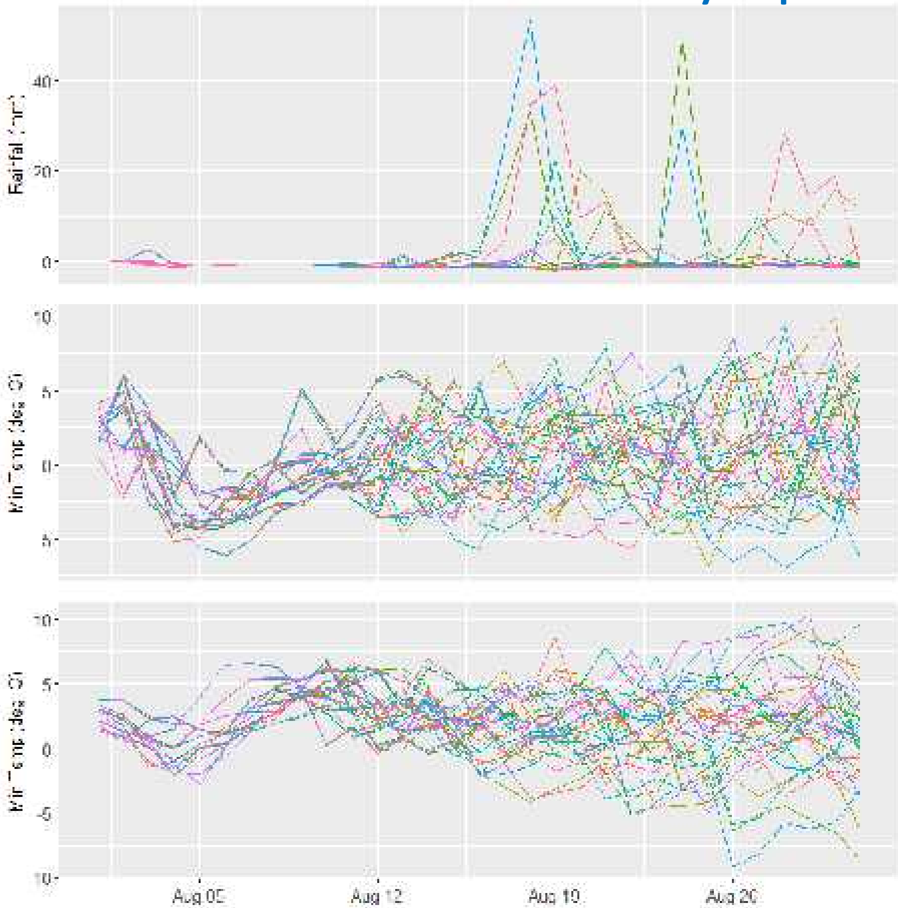
POAMA ensembles for Gympie



POAMA anomalies for rainfall, and minimum and maximum temperature for the 33 ensembles for August 2013.

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POAMA ensembles for Gympie

- Selecting ensemble means for model POAMA model A, B, and C
- Using year 2013 as forecast year
- Calculating rainfall, and min and max temperature for August 2013 from POAMA anomalies and long-term mean climate data
- Running DayCent from 1905 to 2012 as model spin-up
- Estimating yield potential and N mineralization for August 2013

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Simulation Results

	Observed weather	POAMA ensembles A	POAMA ensembles B	POAMA ensembles C
Yield (kg N/ha)	10.2	10.5	10.6	10.5
Mineralisation for August 2013 (kg N/ha)	6.3	9.3	9.8	8.7
N deficiency (kg N/ha)	**3.9**	**1.2**	**0.8**	**1.8**

DayCent predicts a fertiliser requirement of 0.5-1.0 kg day

Conclusions

- N turnover in dairy pastures is difficult to simulate.
- Calibration is essential (better N turnover data needed).
- Promising approach if N mineralisation and yield potential can be simulated adequately.
- Value of forecasts needs to be tested.
- N_2O reduction from reduced fertiliser rates possible.
- Not suitable for ERF methodology (yet?).

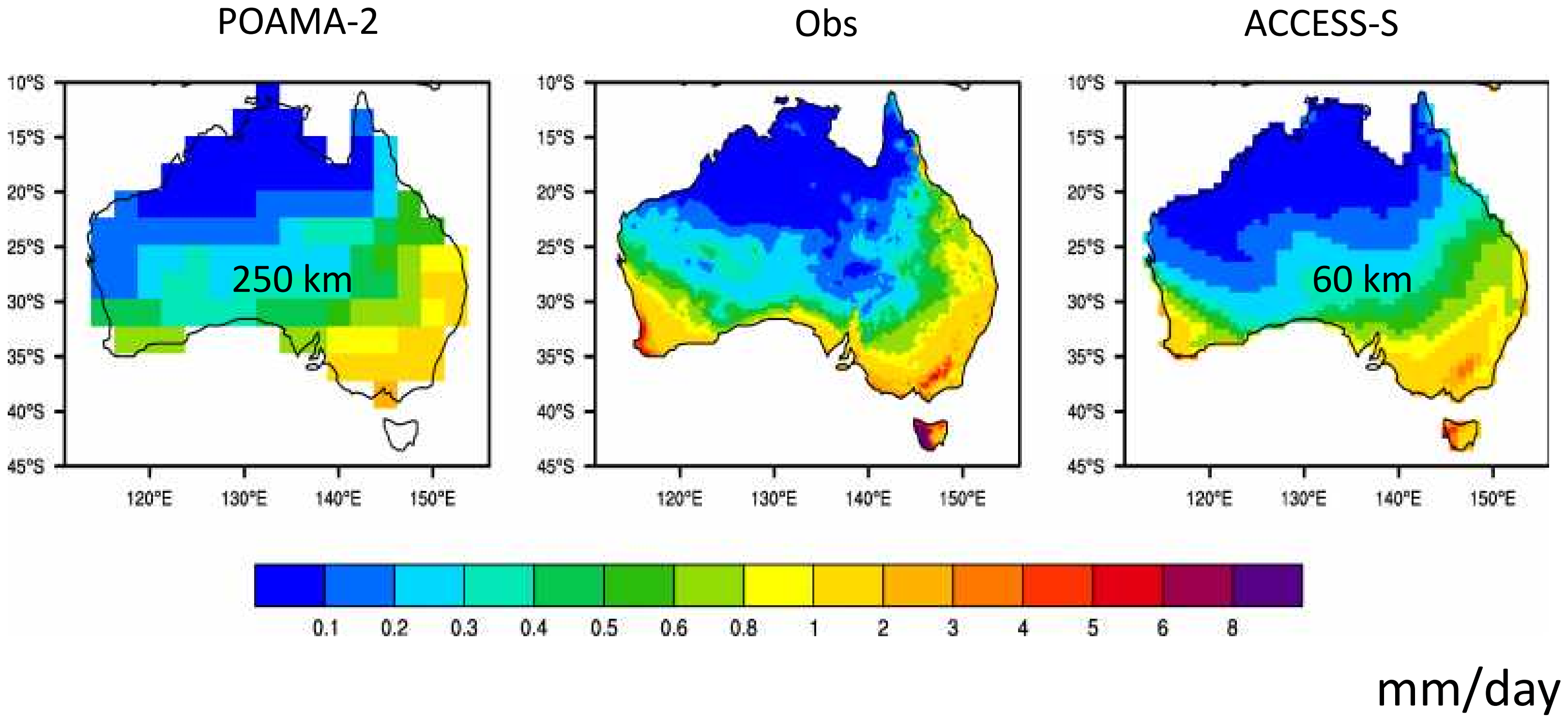
Next Steps

- Calculate fertiliser requirement for all (fertilised/winter) months.
- Validate results by running DayCent with different fertiliser rates.
- Assess impact on N_2O emissions.
- Assess value of forecasts on mineralisation estimates.
- Integrate with irrigation.
- Field validation?

Enhanced resolution

August Mean Rainfall

Higher resolution greatly improves the depiction of mean rainfall



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