Effects of management practices on the carbon balance of Waikato dairy farms

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Outline

- Why carbon balances of dairy farms?
- Scott Farm (2008-2012) – effects of cultivation
- Troughton Farm (2011 – now) – effect of re-grassing to mixed sward
  - Experimental design
  - Results so far
- Methodological challenges

Soil C changes under pastoral agriculture

-resampling study -

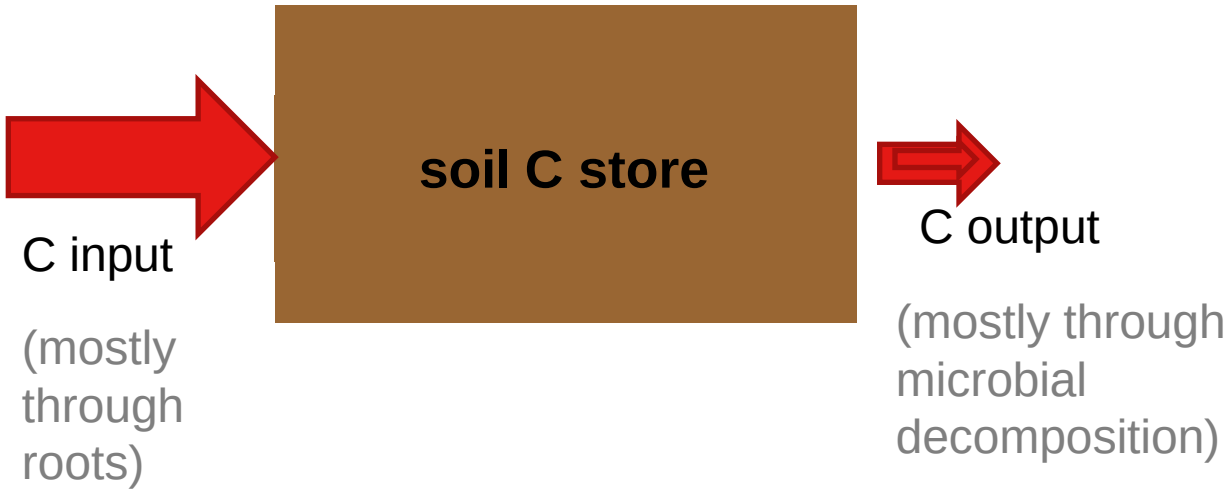
C losses of ≈1 t ha y^{-1} after 30 years for dairy, but no change (or gains) for non-dairy

(Schipper et al. (2010) Agriculture, Ecosystems & Environment, 139: 611-617)

→ Potential opportunity to increase storage in dairy soils

Goal

To identify management practices that can increase soil C gains or decrease losses



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Annual carbon budget

Eddy covariance

NEE = net ecosystem CO_2 exchange

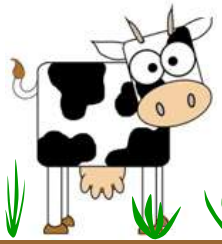
respiration

photosynthesis

CH_4

Farm records

C imports/exports



soil C store

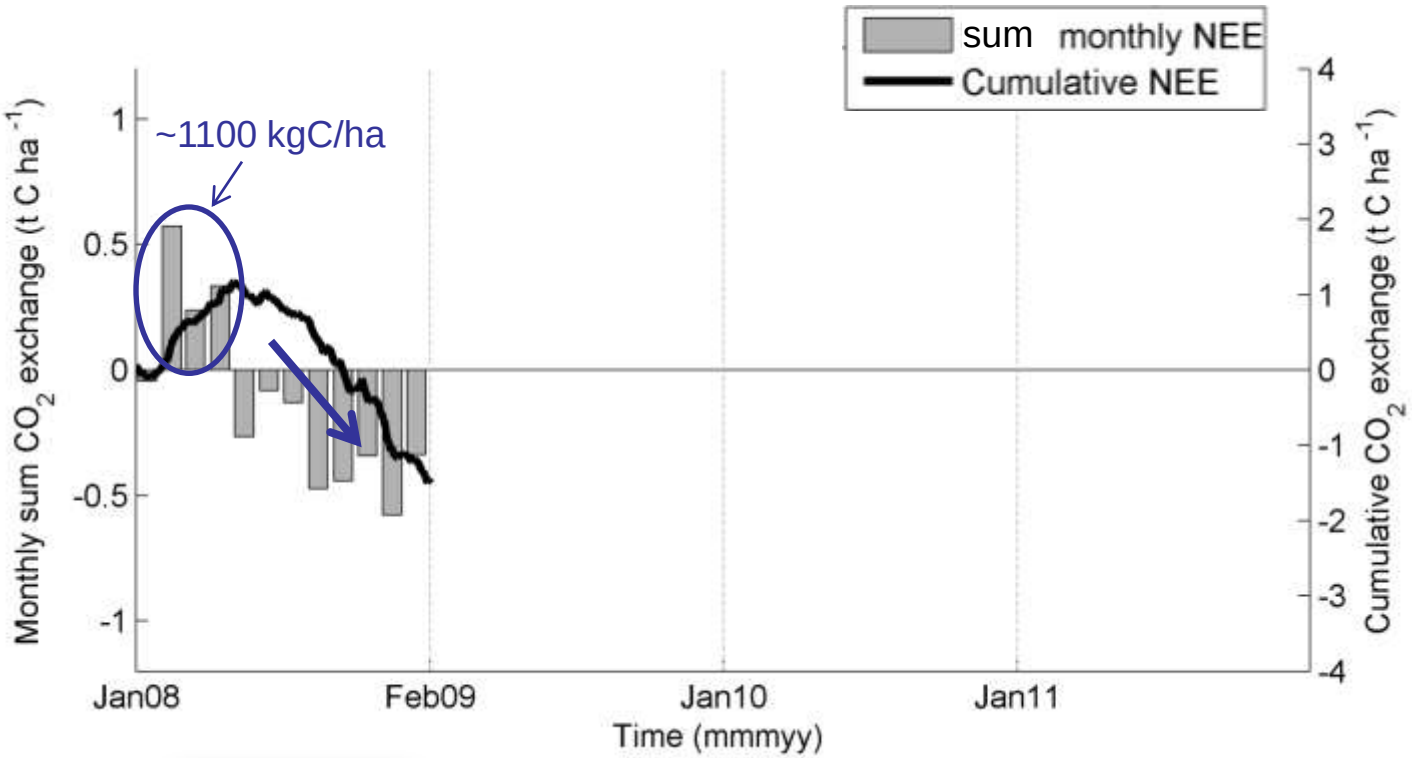
erosion

Leaching

Field site: Scott Farm

- Scott farm (DairyNZ research farm)
- Dec 2007 – Feb 2012

Scott Farm 2008-2011

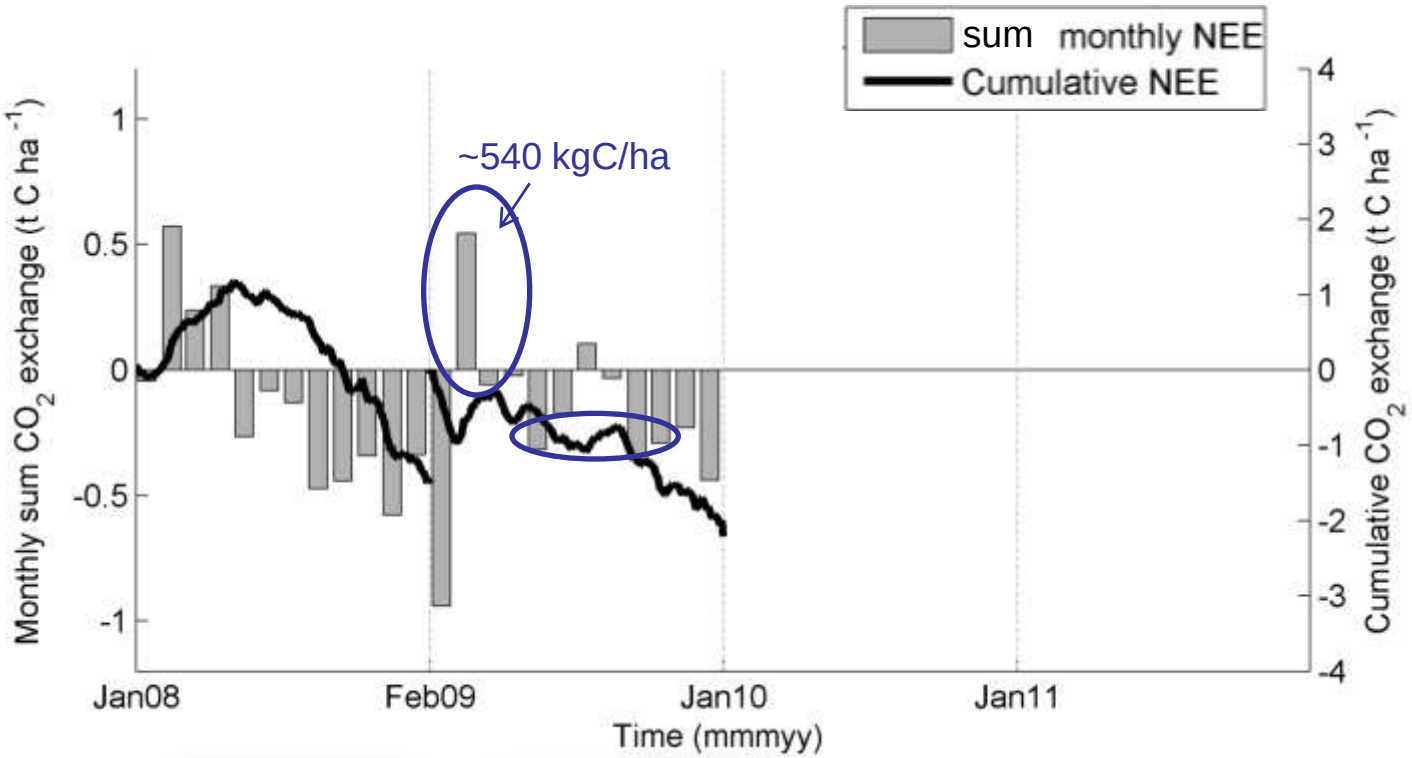


C loss

C gain

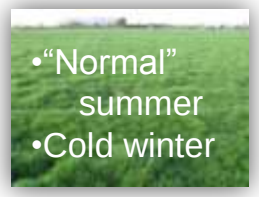
Data for 2008 and 2009: Mudge et al., (2011) Agriculture, Ecosystems & Environment, 144, 271-280

Scott Farm 2008-2011



C loss

C gain



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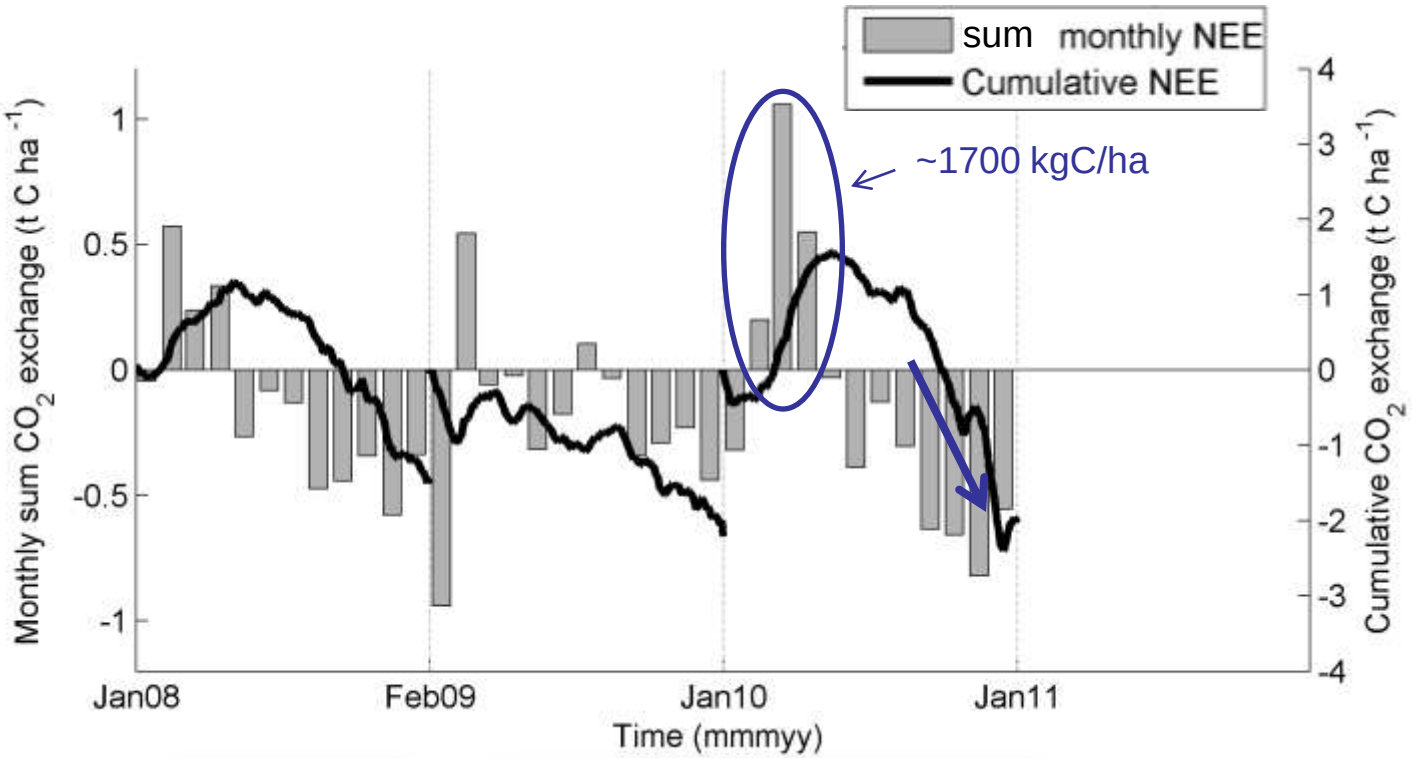
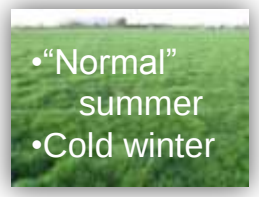
Scott Farm 2008-2011



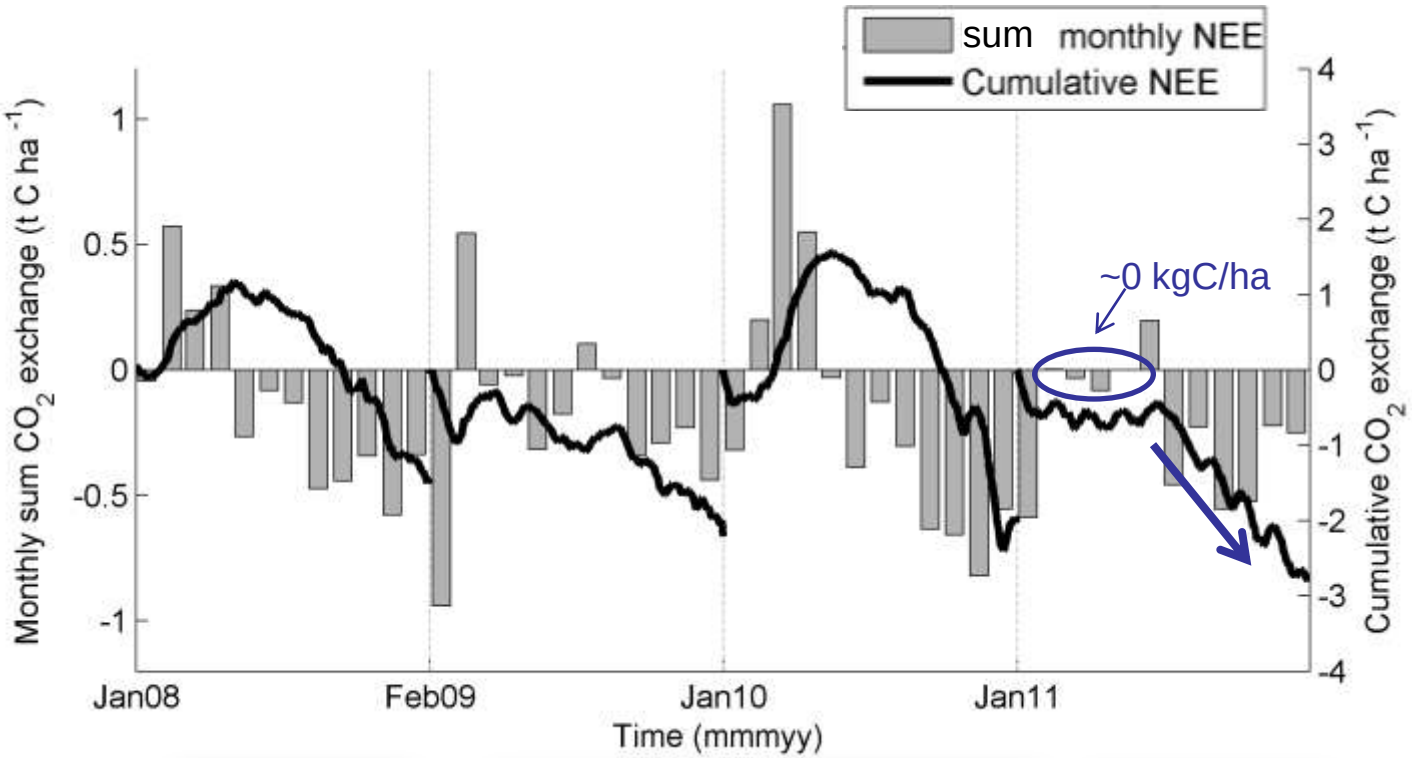
C loss

C gain



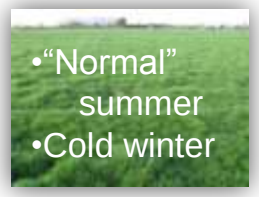
Data for 2010 and 2011 are preliminary

Scott Farm 2008-2011



C loss

C gain



Data for 2010 and 2011 are preliminary

Can a high diversity sward increase soil C ?

- side-by-side experiment -

- Compare rye grass + clover with a high diversity (mixed) sward that has more and/or deeper roots

Hypothesis:

more roots

→ more C input

→ more C storage?

vs.

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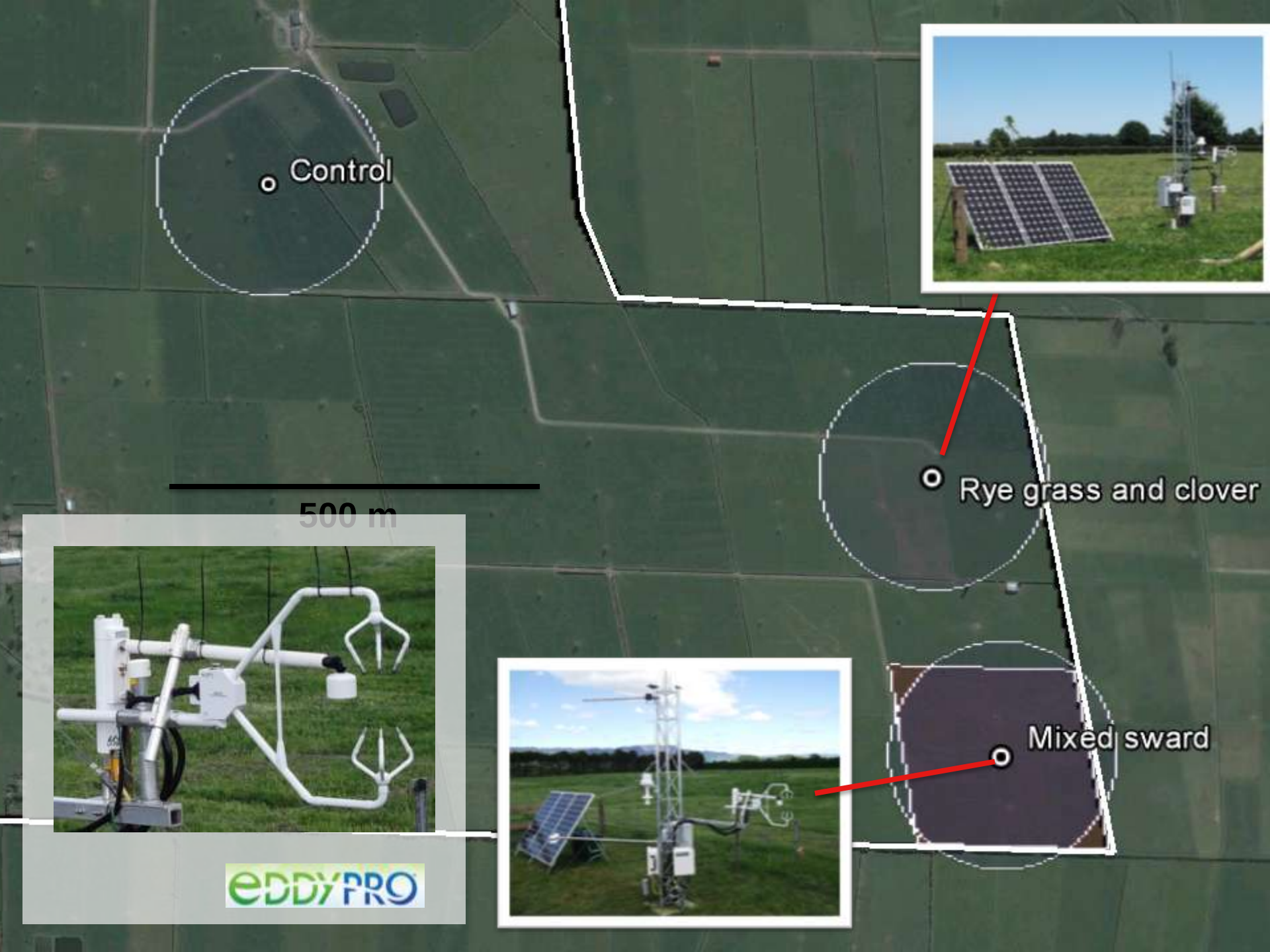
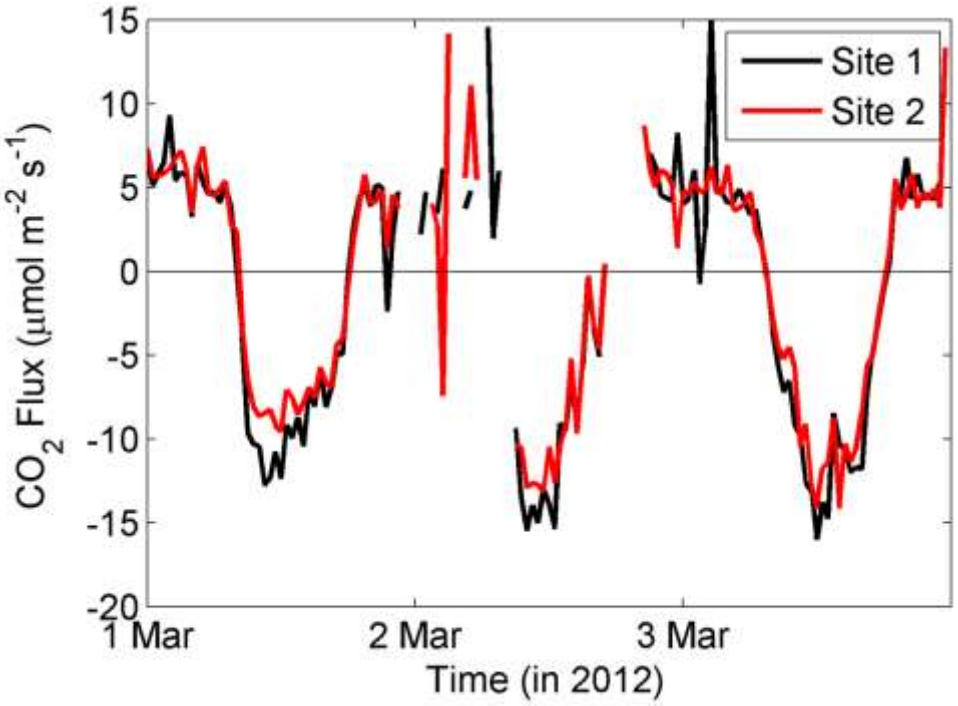
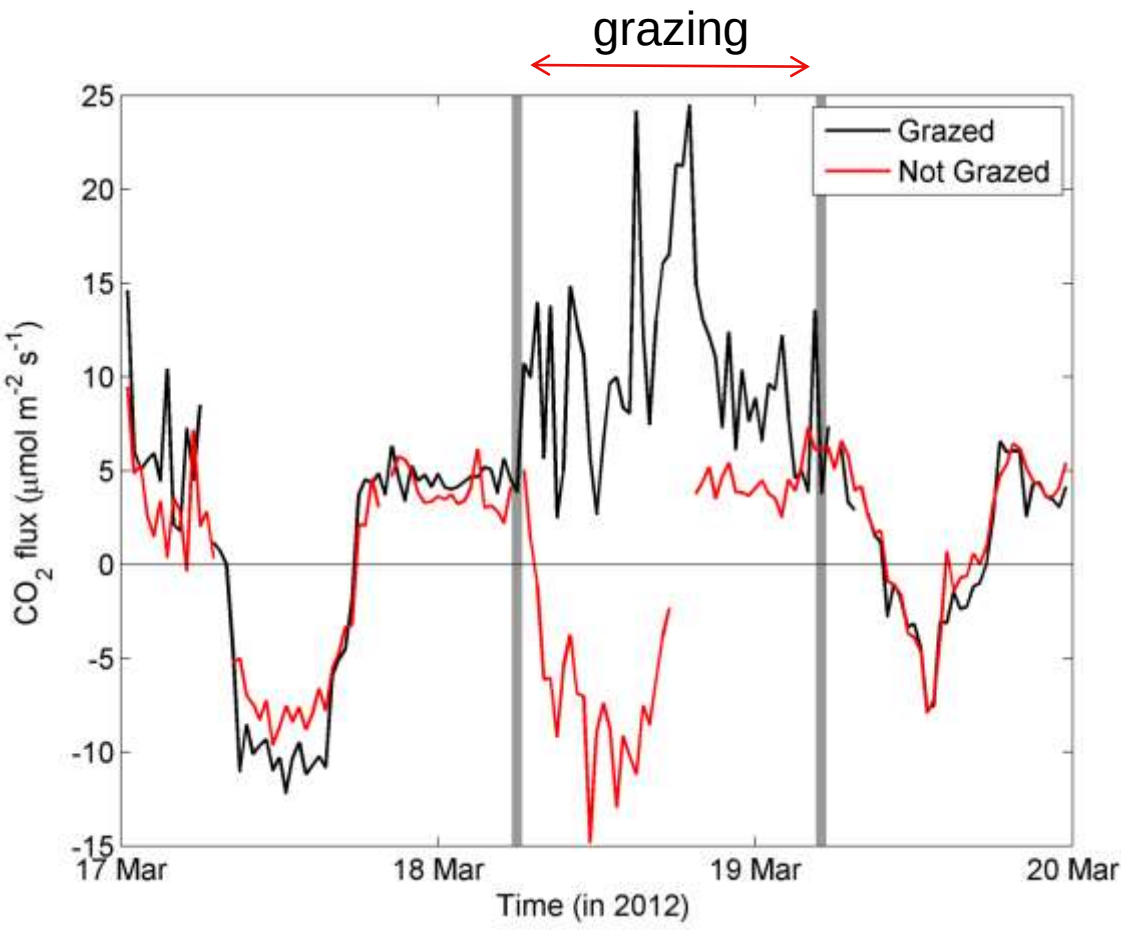

Control
Rye grass and clover
Mixed sward
500 m
eddyPRO

Preliminary data:
flux comparison before regrassing

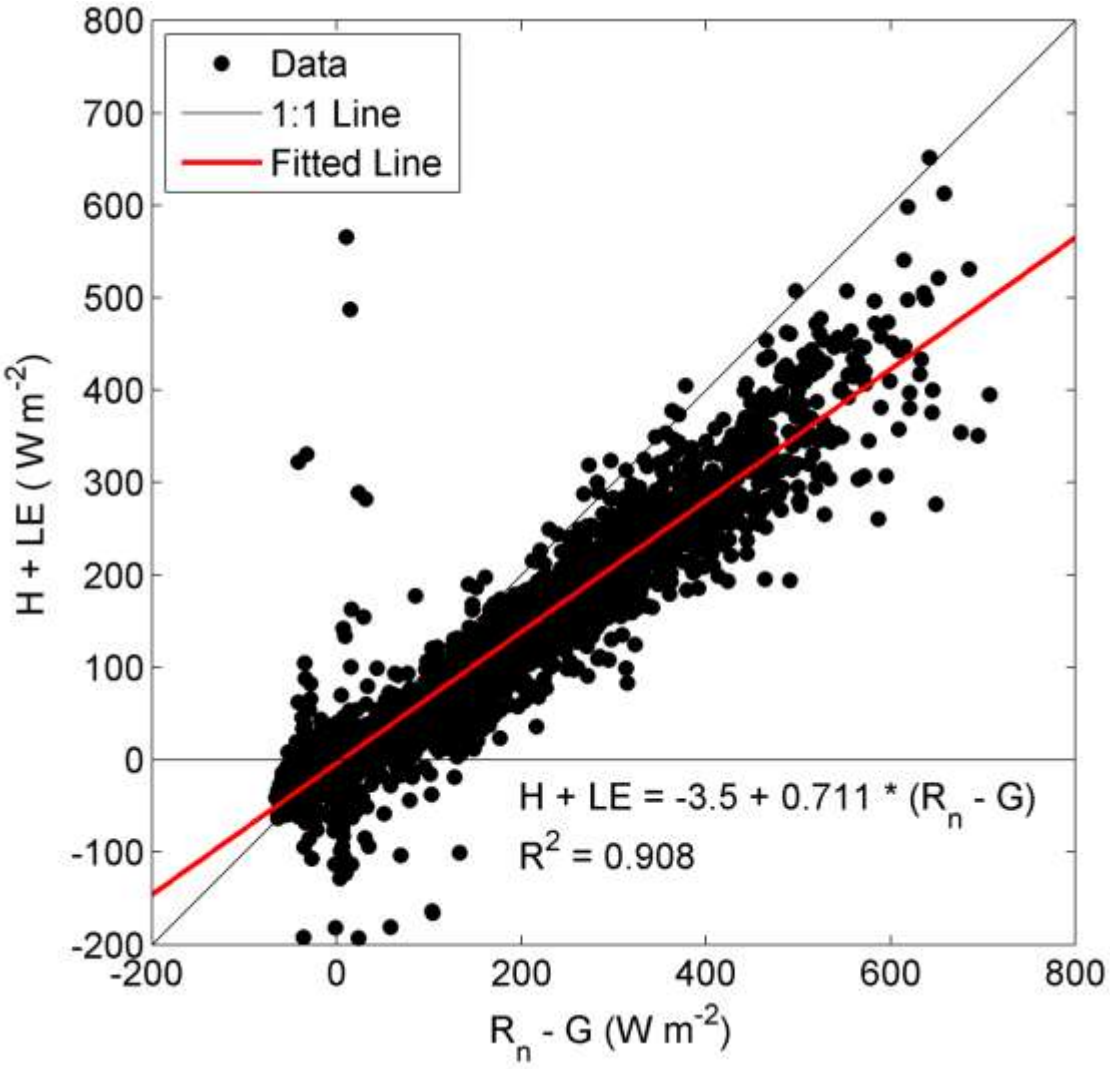


both sites still in rye grass

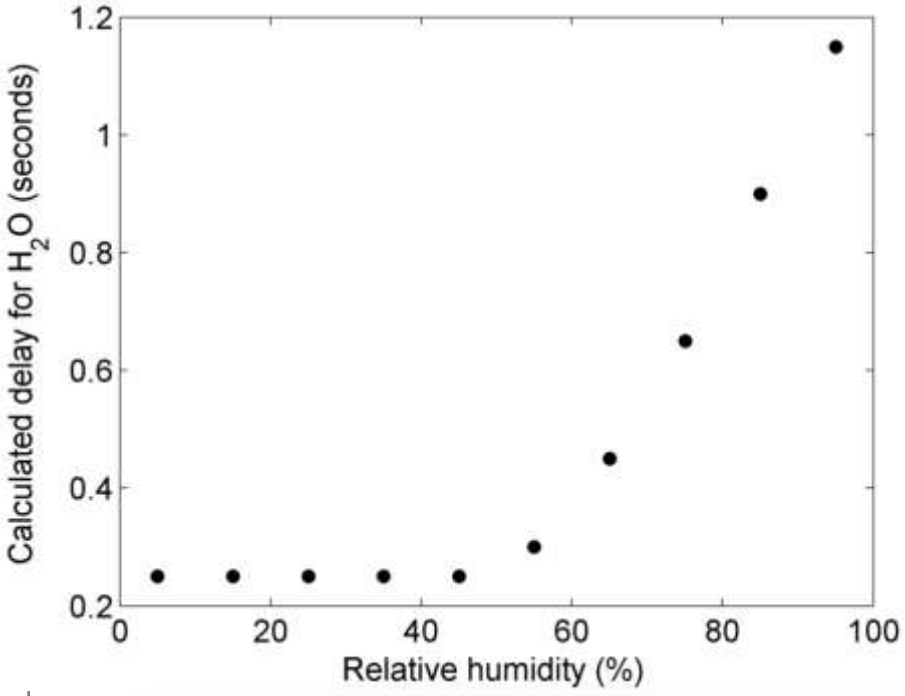
Effect of grazing

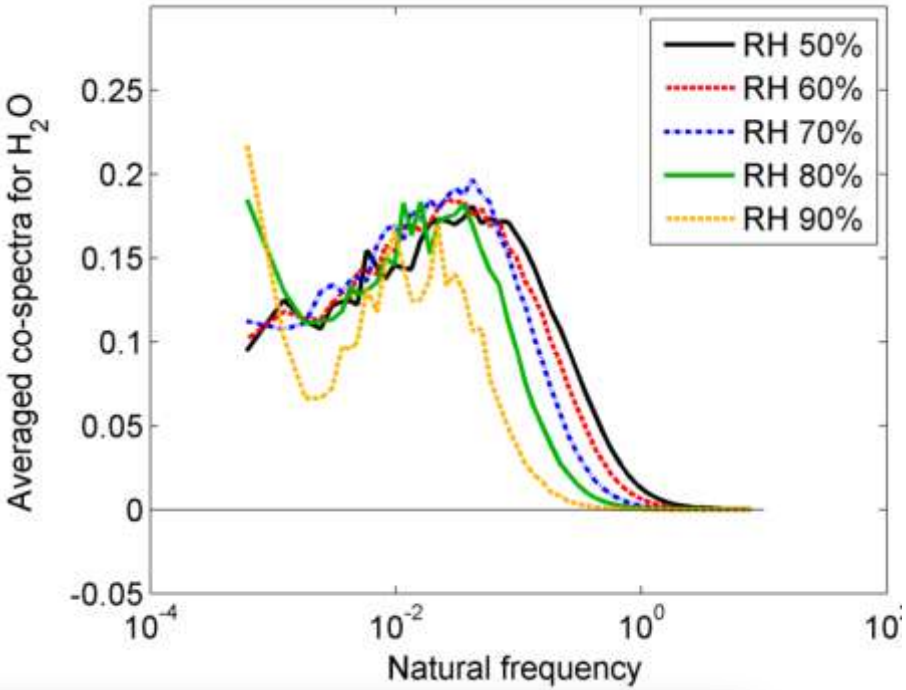


Challenges: lack of energy balance closure

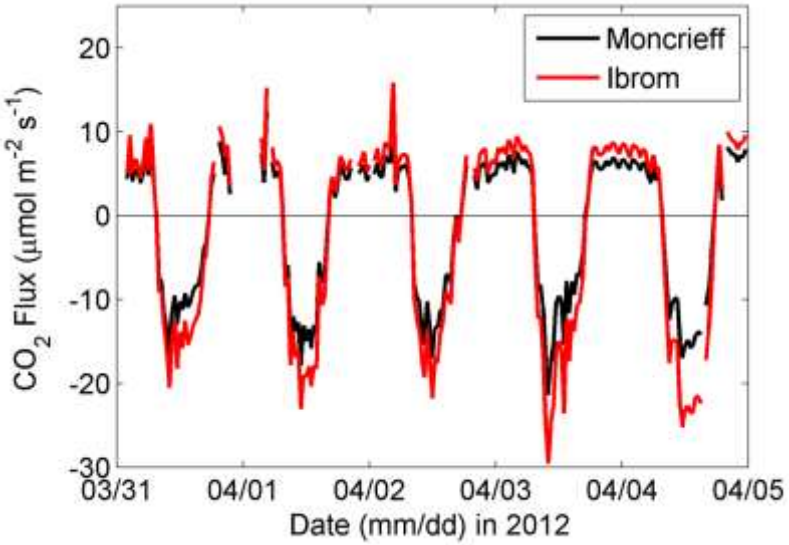


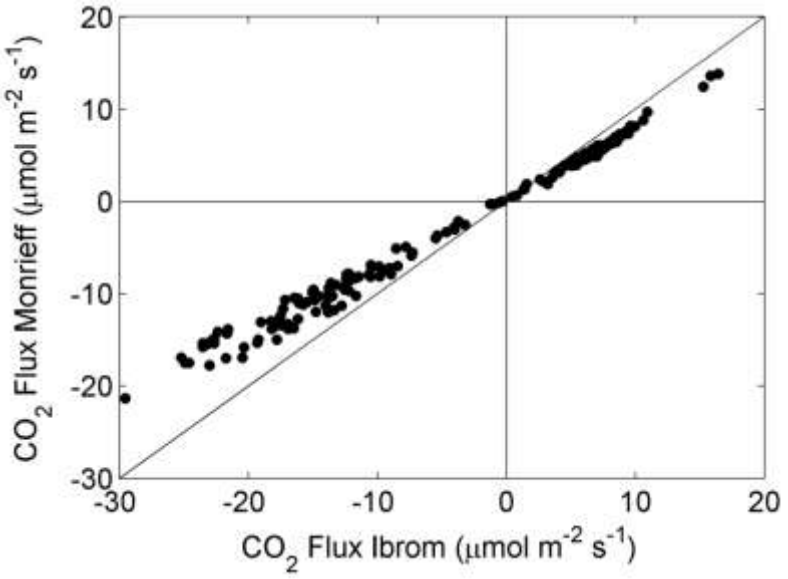
Challenges: underestimation of evaporation?





Challenges:
frequency response correction – CO_2 flux

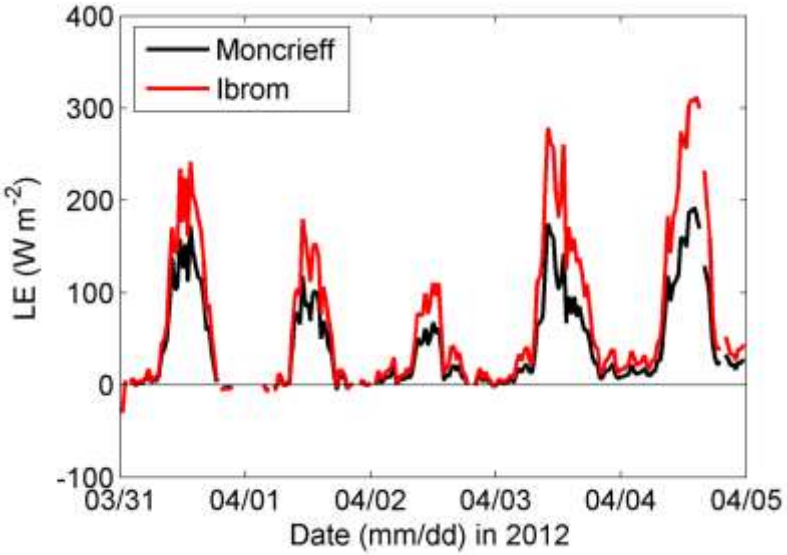


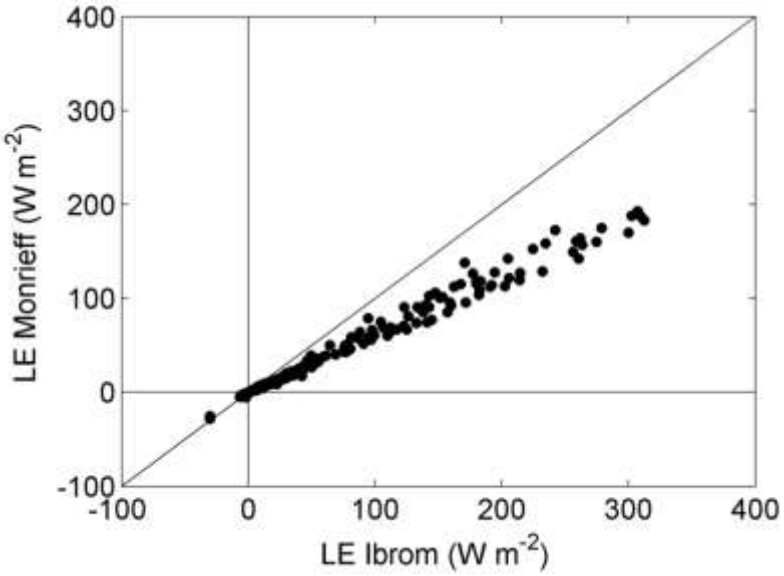


Moncrieff, J. B., et al. 1997. A system to measure surface fluxes of momentum, sensible heat, water vapor and carbon dioxide, Journal of Hydrology, 188-189: 589-611.

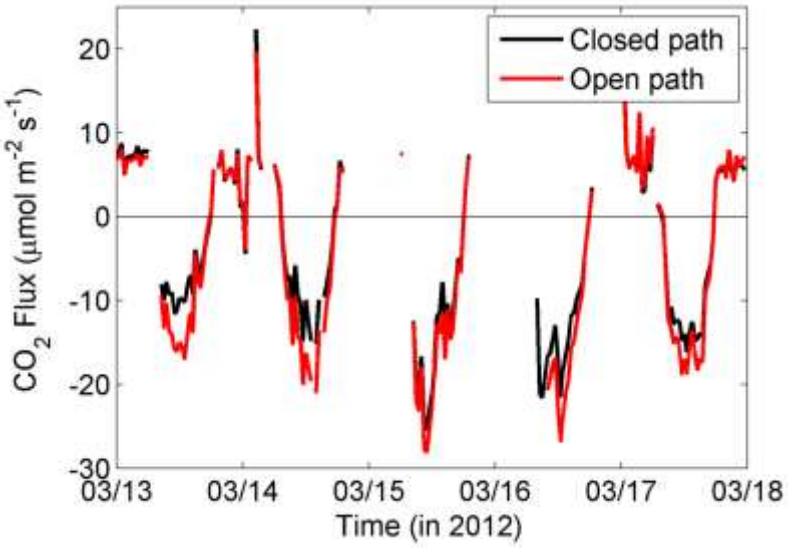
Ibrom, A., et al. 2007.Strong low-pass filtering effects on water vapor flux measurements with closed-path eddy correlation systems, Agricultural and Forest Meteorology, 147:140-156.

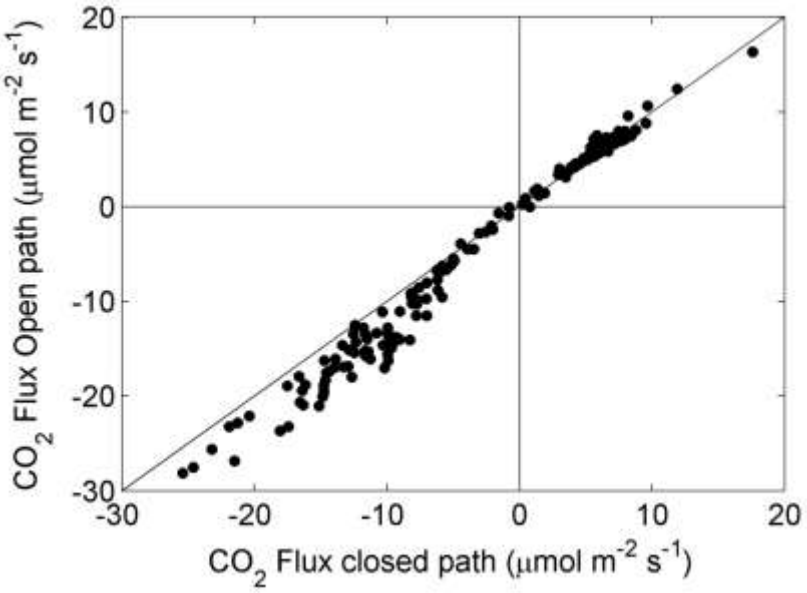
Challenges:
frequency response correction – LE





Closed path vs. Open path - CO_2 flux

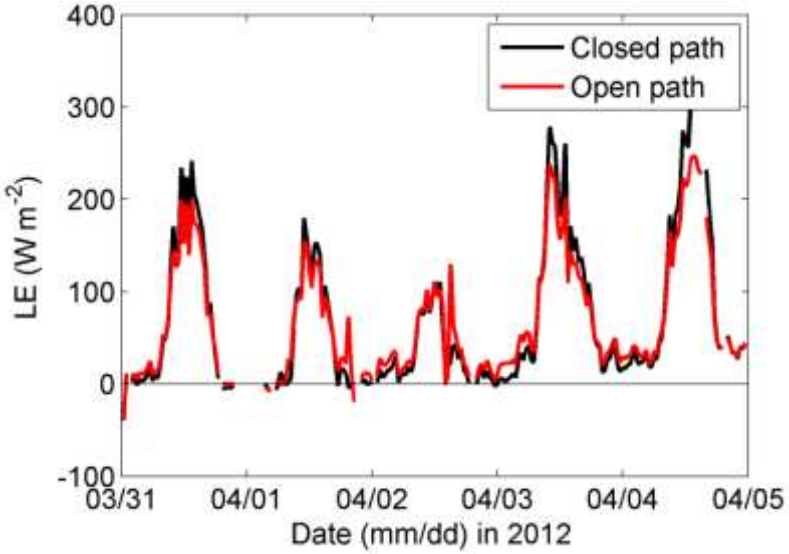


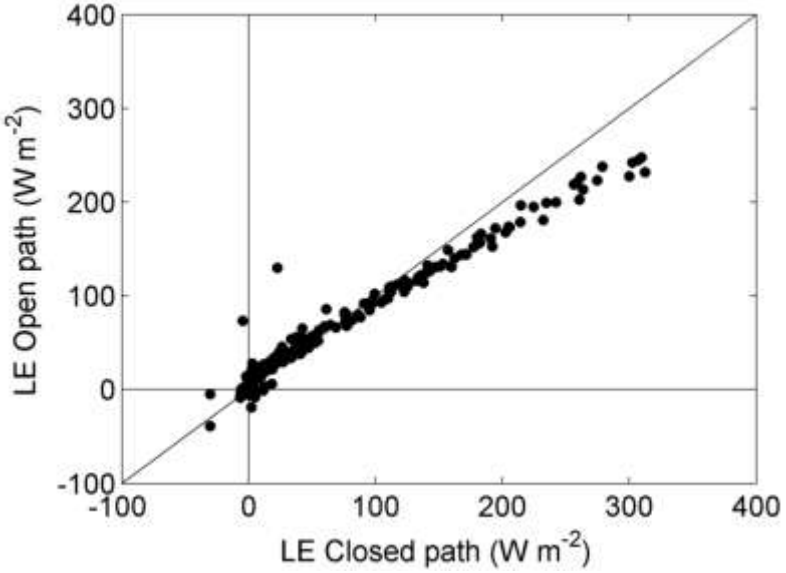


But different frequency response correction applied:

- Closed path: Ibrom
- Open path: Moncrieff

Closed path vs. Open path - LE





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- Closed path: Ibrom
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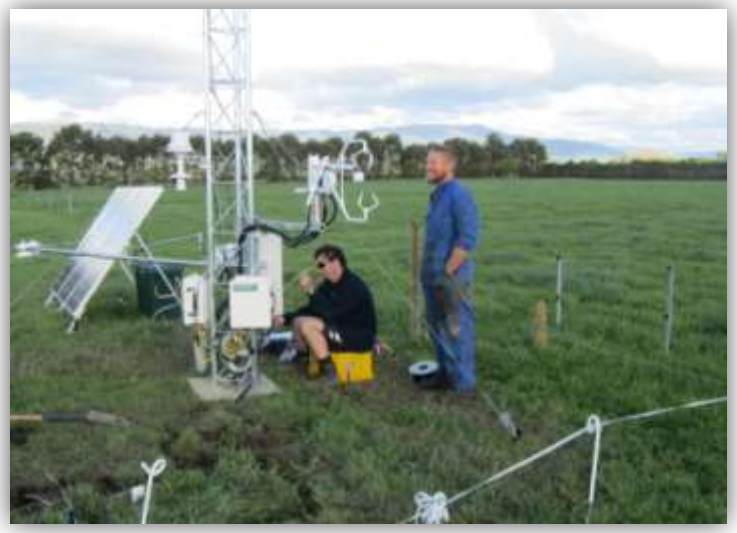
Conclusions

- Even after cultivation, Scott farm was a sink for CO_2 on an annual timescale
- Preliminary results suggest that regrassing to mixed sward may increase the CO_2 sink strength
- Triple-site comparison underway
- Low energy balance closure
    - Low installation height?
    - Closed path?
    - Storage fluxes?
    - Site-specific frequency response?

Acknowledgements

- Ben and Sarah Troughton
- Paul Mudge
- Dairy NZ staff
- David Whitehead
- Craig Hosking
- Dirk Wallace



Funding

- New Zealand Agricultural Greenhouse Gas Research Centre
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- Dairy NZ

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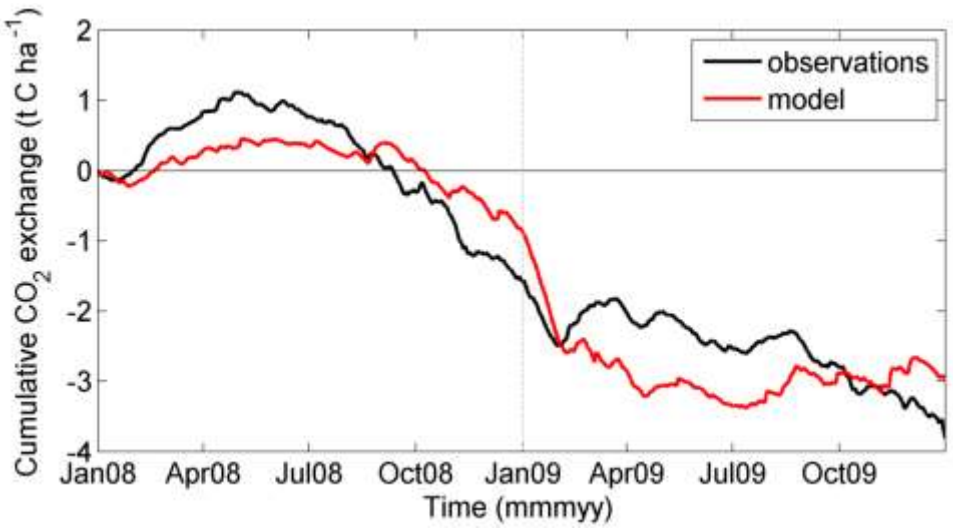
Landcare Research Manaaki Whenua

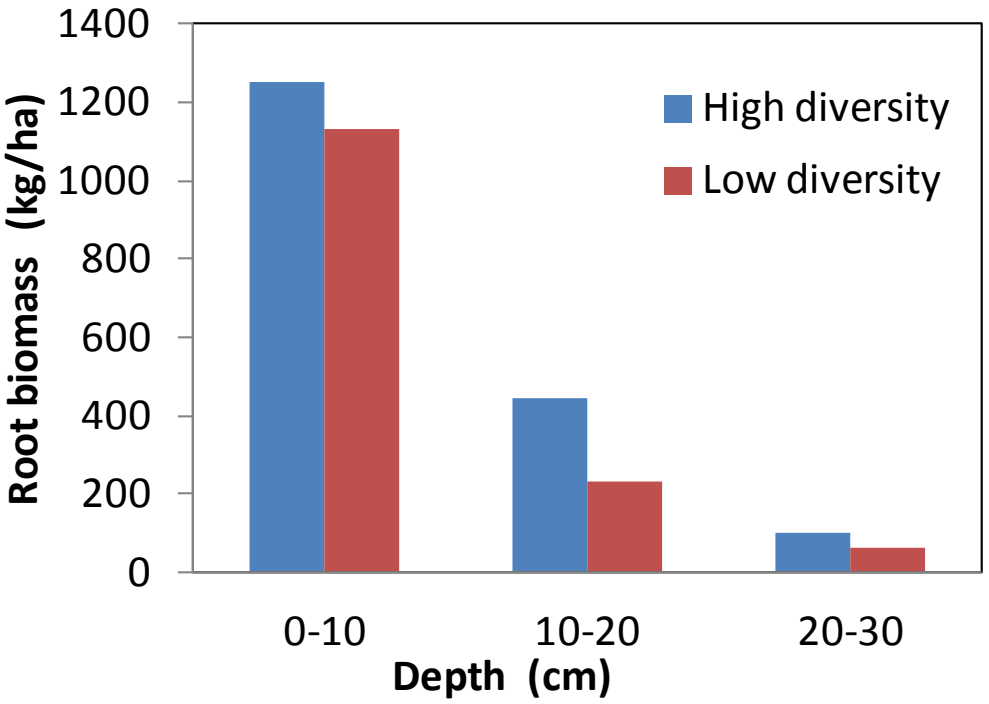
DairyNZ

Modelling collaboration

- Miko Kirschbaum and student Isoude Kuijper using CenW
  - Disentangle weather drivers from management effects
  - Fate of C (which pools)
- Two way collaboration: feedback to interpret results



Higher root biomass of high diversity sward



- 25% more roots (0-30 cm) in mixed sward compared to traditional rye grass/clover

Experimental design