CO_2 flux investigations for intensive dairy farms and wetlands in the Waikato Region, NZ

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Soil C changes under pastoral agriculture

	Change in soil C (0-30 cm) (T C ha^{-1} y^{-1})
Dairy	-0.73***
Drystock flat	-0.14 *ns*
Drystock hill	0.52*
Drystock tussock	0.0 *ns*

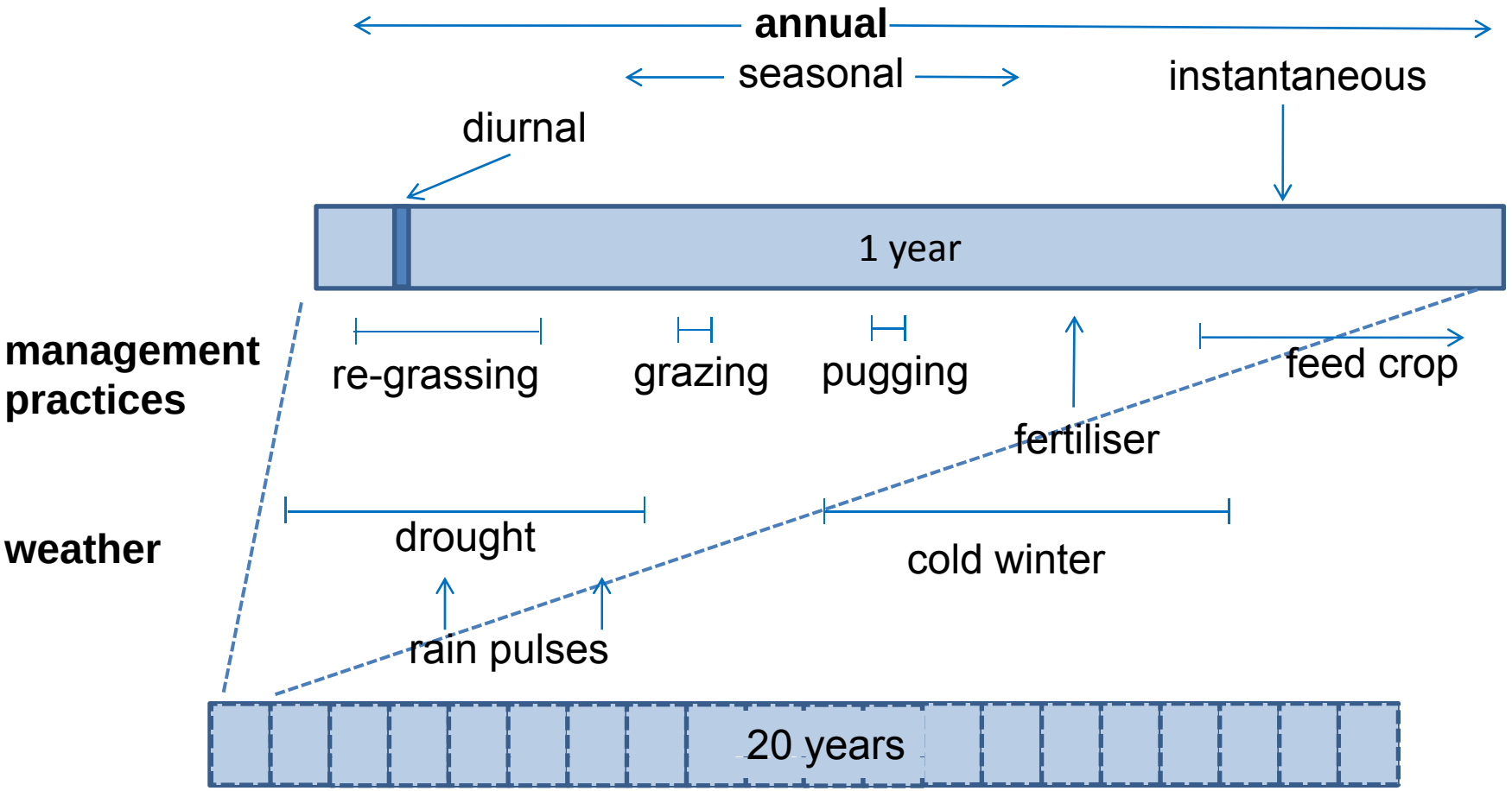
Photos by Larry Burrows

→ Soils under dairying are the ones that lost carbon

→ Opportunity to increase storage

Schipper LA, Parfitt RL, Ross C, Baisden WT, Claydon JJ, Fraser S (2010) Gains and losses in C and N stocks of New Zealand pasture soils depend on land use. Agriculture, Ecosystems & Environment, 139, 611-617.

What factors drive changes in soil C?



- land-use change
- economic drivers
- inter-annual variability
- climate change

Net ecosystem carbon balance (Annual C budget)

NEE = net ecosystem CO_2 exchange

CH_4

respiration

photosynthesis

cow

leaves

C imports/exports

roots

microbes

long-term soil C store

erosion

Leaching

1. Eddy covariance to measure net CO_2 exchanges in a pasture system

2. Chamber to measure soil respiration

3. Farm records for imports/outputs

New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC)

- 100% government funded
- Aims to mitigate agricultural GHG emissions without reducing productivity
- Mostly pastures
- N_2O, CH_4, soil carbon and farm systems

Goal for our NZAGRC work

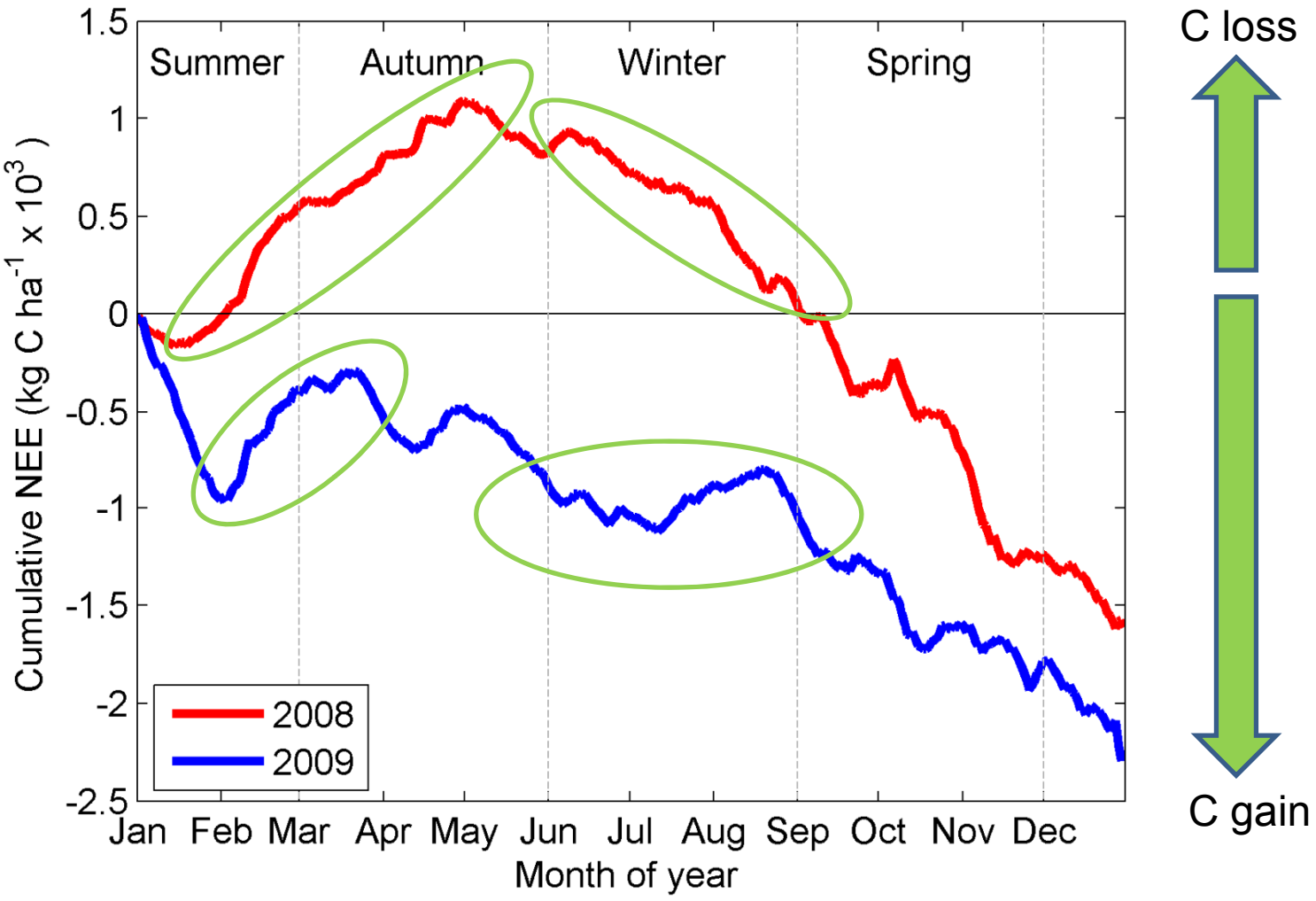
- To determine the effect of management practices on soil carbon balance of dairy pastures with the aim to increase C gains or decrease losses

- To increase C soil stock:
  - Increase C input (mostly by increasing root inputs)
    or
  - decrease C output (mostly by decreasing decomposition)

Experiment 1: interannual variation at Scott Farm

- Scott farm study site (DairyNZ research farm)
- established Dec 2007

Effect of weather on CO_2 exchange



Mudge PL, Wallace DF, Rutledge S, Campbell DI, Schipper LA, Hosking CL (submitted) Carbon balance of an intensively grazed temperate pasture in two climatically contrasting years. Submitted to Agriculture, Ecosystems & Environment.

C budget of Scott Farm

Flux	2008	2009	2010
Photosynthesis	19,835	24,045	
Respiration	18,225	21,755	
-NEE	+1,610	+2,295	
Feed import	+175	0	
Milk export	-795	-930	
Silage export	-65	-100	
Methane	-200	-215	
Erosion	assumed 0	assumed 0	
Leaching	-55	-55	
NECB	**590 ± 560**	**900 ± 560**	

Units kg C $ha^{-1}yr^{-1}$

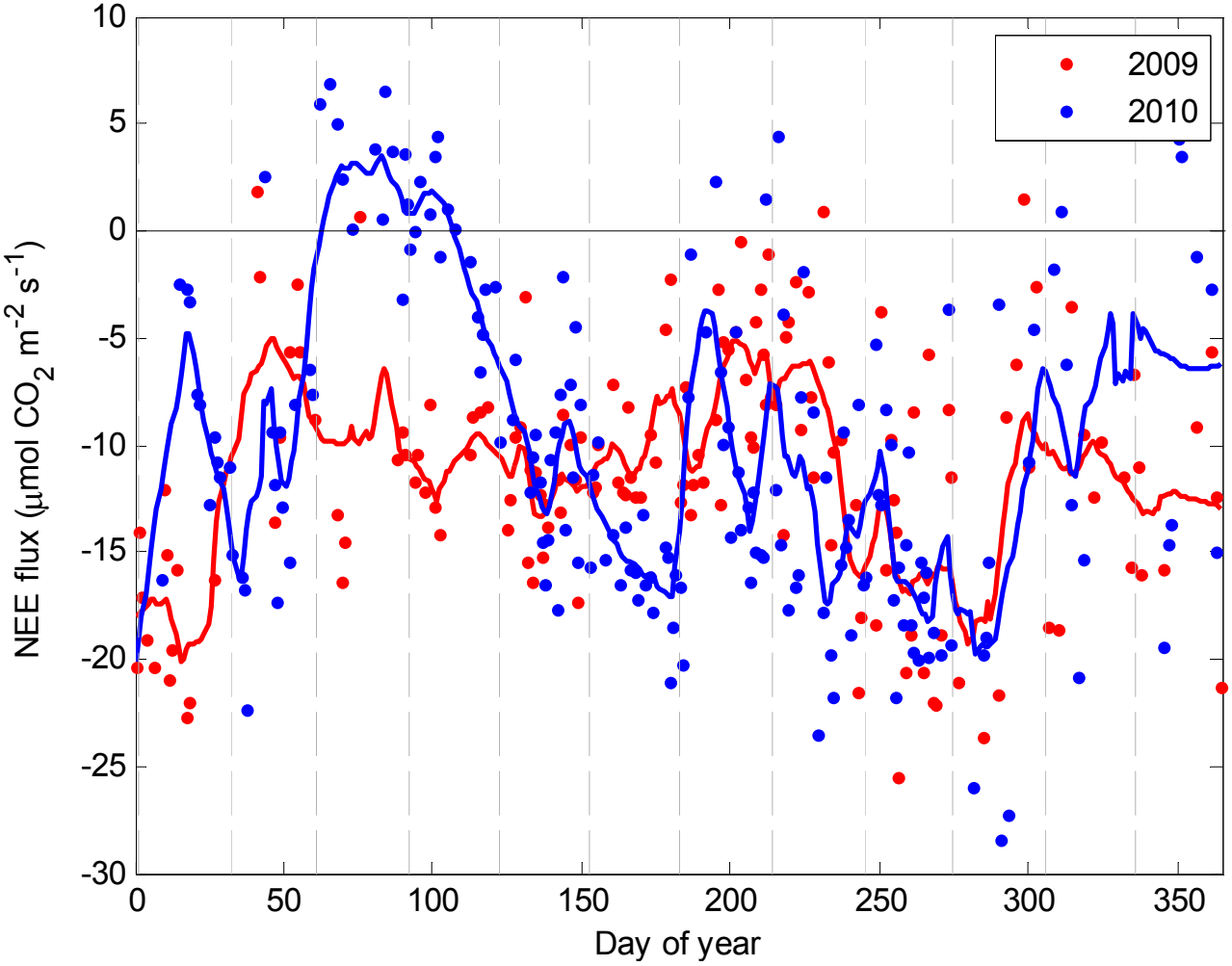
Mudge PL, Wallace DF, Rutledge S, Campbell DI, Schipper LA, Hosking CL (submitted) Carbon balance of an intensively grazed temperate pasture in two climatically contrasting years. Submitted to Agriculture, Ecosystems & Environment.

Experiment 2: Change in outputs - effect of cultivation -

- Plan: Study the effect of a cultivation
- Hypothesis:
  C lost by disturbance of cultivation and stopping of photosynthesis, but more vigorous growth (=C fixation) after renovation

Photos by Paul Mudge

Cultivation - EC



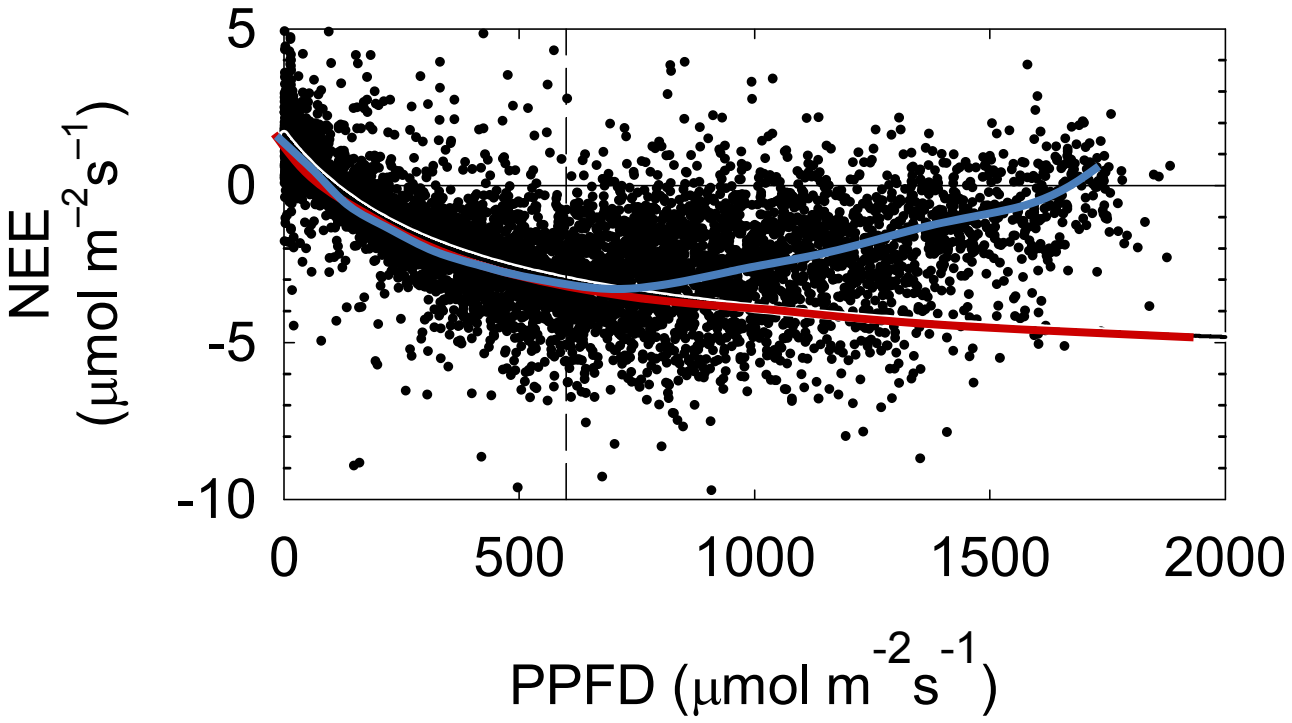
2009 = normal
2010 = cultivation

Preliminary data: only midday values (between 10 am and 2 pm), bin average

Experiment 3: Changes in input - different pasture species -

- Plan: Compare conventional rye grass + clover with a cultivar or mix that has more and/or deeper roots
- Hypothesis: more roots → more C input into the soil
- Side-by-side comparison

Wetland work: Opuatia 2003-2005



→ depressed light response

→ caused by photoinhibition and photorespiration

Paper submitted to Ecosystems: DI Campbell, B Thornburrow, BK Sorrell, S Rutledge, Peatland CO_2 exchange impacted by depression of photosynthesis at high light, submitted.

Planned wetland work

- Part of larger programme which aims to improve restoration and preservation of wetlands
- Long term site at Kopouatai wetland
- Aimed to increase understanding of ecosystem functioning

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