# The role of eddy covariance in determining carbon fluxes in pasture soils

Dave Campbell, Louis Schipper Susanna Rutledge, Paul Mudge & Dirk Wallace Earth and Ocean Sciences University of Waikato



WAIKATC

#### Outline

- Context: observed C losses in NZ pastoral soils
- Measuring CO<sub>2</sub> exchanges with eddy covariance and chambers
- Paddock-scale annual C budgets (dairying)
- Quantify effects of individual farm management practices on CO<sub>2</sub> exchanges
- State of the balance sheet
- Non-biological C loss

### Soil C changes under pastoral agriculture



- C losses of ≈1 t ha y<sup>-1</sup> after 20 years for dairy but gains for hill country (Schipper et al. (2007) Global Change Biology, 13: 1138-1144)
- What land management practices contribute to C loss, and at what rate?

### What factors drive changes in soil C?



C exchanges in a pasture system using EC

- Annual C budgets
  - Hectare scales
  - 1/2 hr to multi-year
- Biophysical drivers
  - Model formulation & testing



#### C budget 1: dairy farm on peat



### C budget 2: dairy farm on mineral Soils

#### Pasture NEE in a drought year



Paul Mudge MSc thesis

#### Partitioned & total NEE



#### Paddock-scale C budget

Units kg C ha<sup>-1</sup>



Paul Mudge MSc thesis

### How do management practices alter C fluxes?



#### 1. Cultivation in a summer drought

- 27 January 5 March 2008
- 6 paddocks
  - 3 cultivated
  - 3 pasture
- LI-COR 8100 soil respiration system
- 10 soil respiration sampling collars in each paddock
- Measurements made over period of 39 days



#### Cultivation trial results

	Cultivated	Pasture
Respiration (C losses, chamber)	38.4	37.1
Gross Primary Production (EC)	_	14.7
NEE	38.4	22.4
	kg C ha <sup>-1</sup>	kg C ha⁻¹
NEE 39 day trial	1496	874
Net ecosystem exchang	Net loss	
But this was during a	622 kg C ha <sup>-</sup>	

#### 2. Pugging event in winter



#### Pugging trial results

	Pugged	Control (pasture)
C losses-daily (kg C ha <sup>-1</sup> d <sup>-1</sup> )	28.3	33.7
C losses–41 days (kg C ha <sup>-1</sup> )	1,161	1,381



## 3. Strip grazing event on a Waikato peat soil



(2005) Global Change Biology. 11: 607-618.

#### 4. Cultivation during spring





Soils: Te Kowhai

#### Horotiu







#### Spring cultivation trial results

	Te Kowhai	Horotiu
	kg C ha <sup>-1</sup> d <sup>-1</sup>	kg C ha <sup>−1</sup> d <sup>−1</sup>
Respiration	71.2	43.6
GPP (EC)	—	—
NEE	71.2	43.6
	kg C ha⁻¹	kg C ha⁻¹
NEE 34 day trial	2420	1484

Net ecosystem exchange (NEE) loss /gain

	Change in soil C	
	tC ha <sup>-1</sup> yr <sup>-1</sup>	
DOC	0.15-1.5	Balance
leaching	(see Ghani et al poster)	sheets?
Urine priming	??	
		Effect of soil
<u>Cultivation</u>		
Dry	1-2	type
Moist	2-4	
Grazing intensity	0.3	Interannual variability
Pugging	0	
Erosion		Still many
Flat	XX	unknowns!
Hill	XX	
XXX	XX	

### Photodegradation – an overlooked pathway for C loss?

- 20% of annual C losses due to photodegradation in bare peatland
- 60% of dry season
  CO<sub>2</sub> flux due to photodegradation in California



Rutledge et al. (in press) Global Change Biology

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