Nitrous oxide emissions determined by eddy covariance and static chamber methods from a grazed grassland



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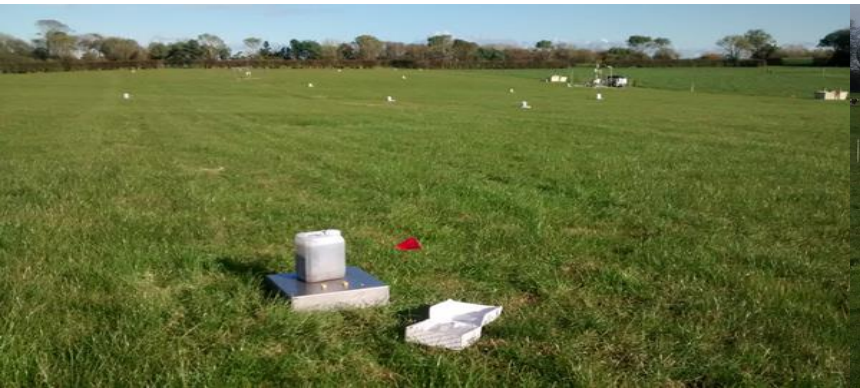
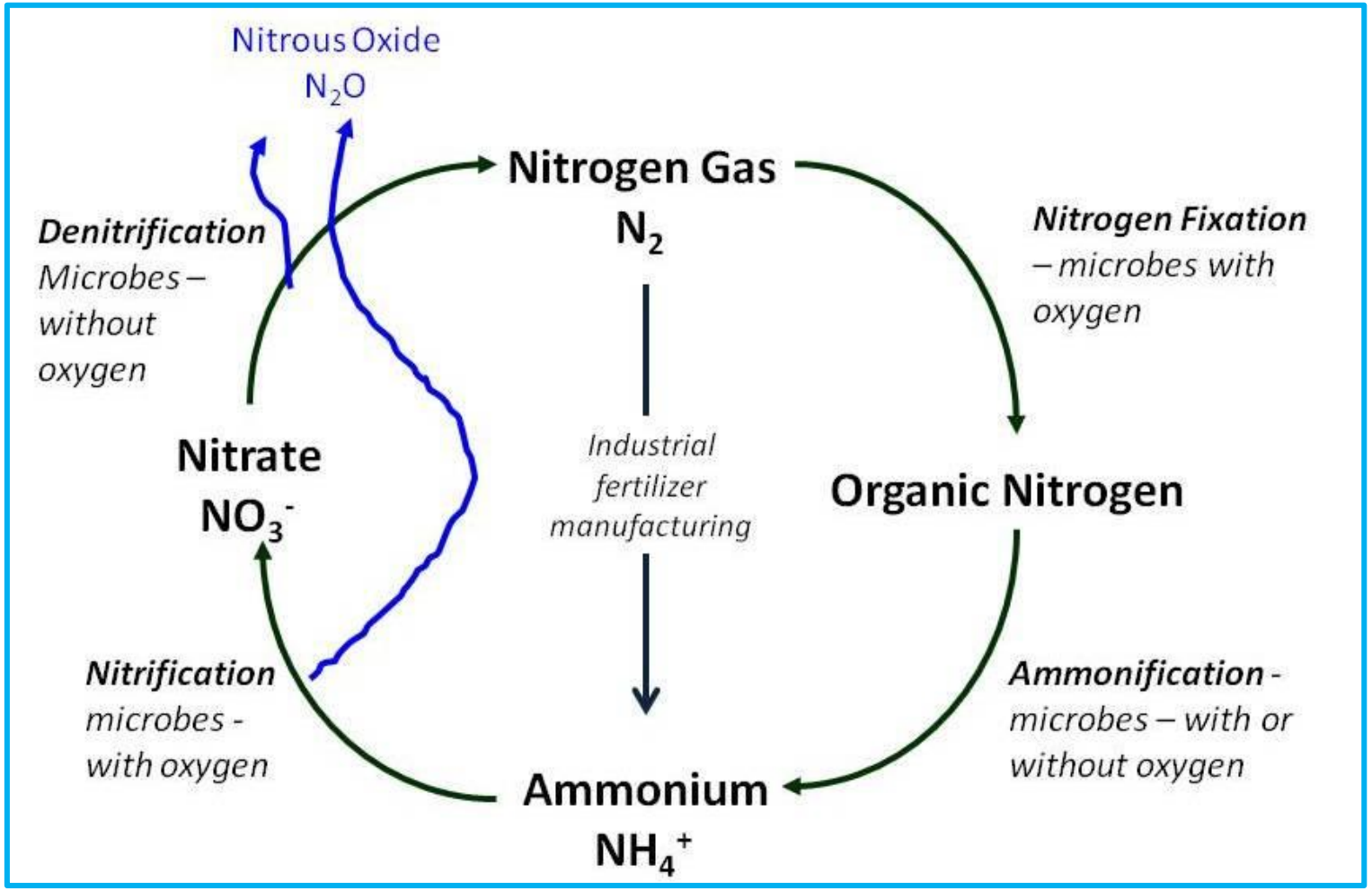
Nitrous oxide emissions in time and space in an intensively managed grassland

- Context
- Methods
- Results
- Conclusions



Nitrous oxide (N_2O)

- N_2O GWP 265
- Climate change
- N cycle
  - Nitrification
  - Denitrification

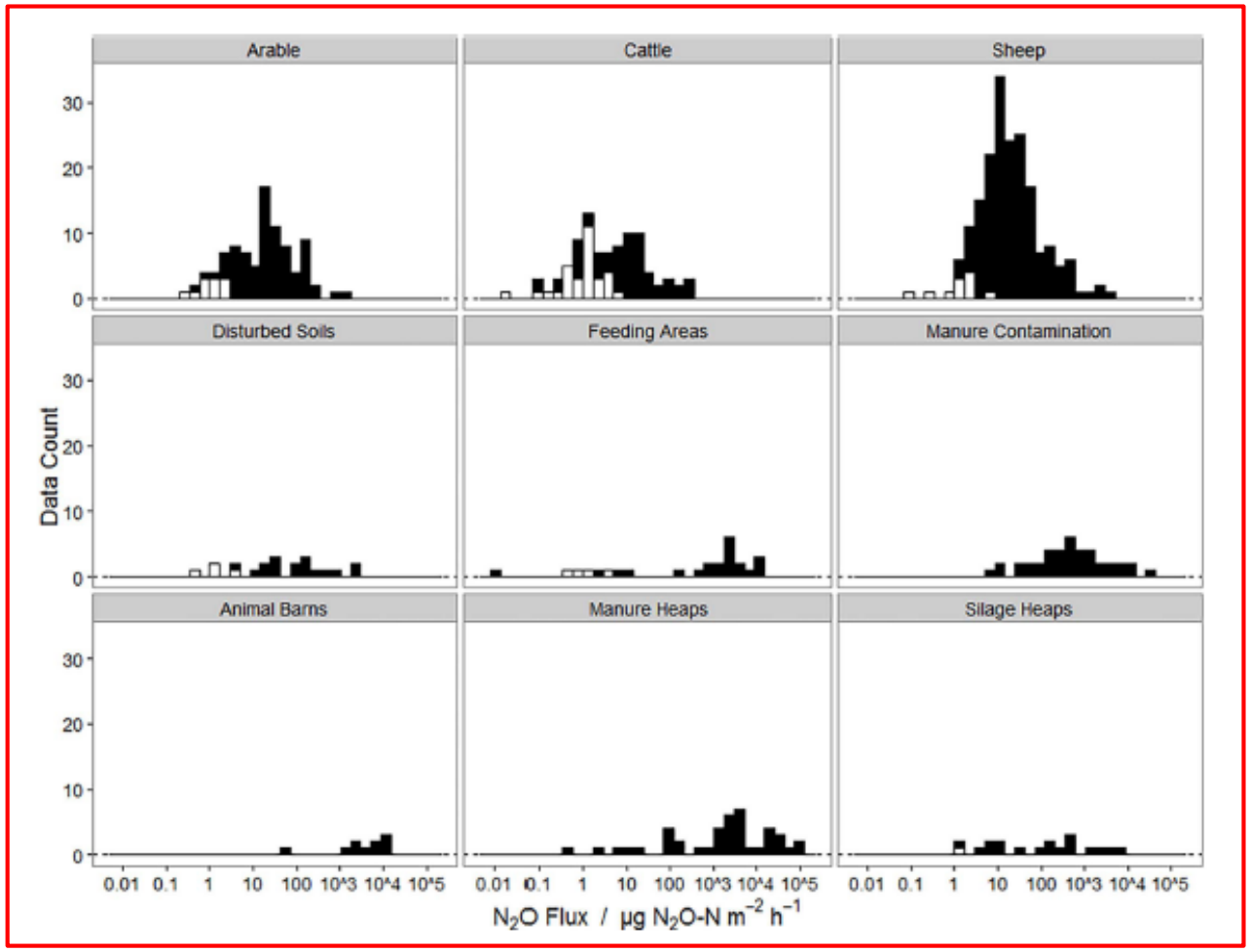


https://johnpaulprofessional.com/2014/09/01/understanding-nitrous-oxide-the-greenhouse-gas-of-most-significance-in-agriculture/

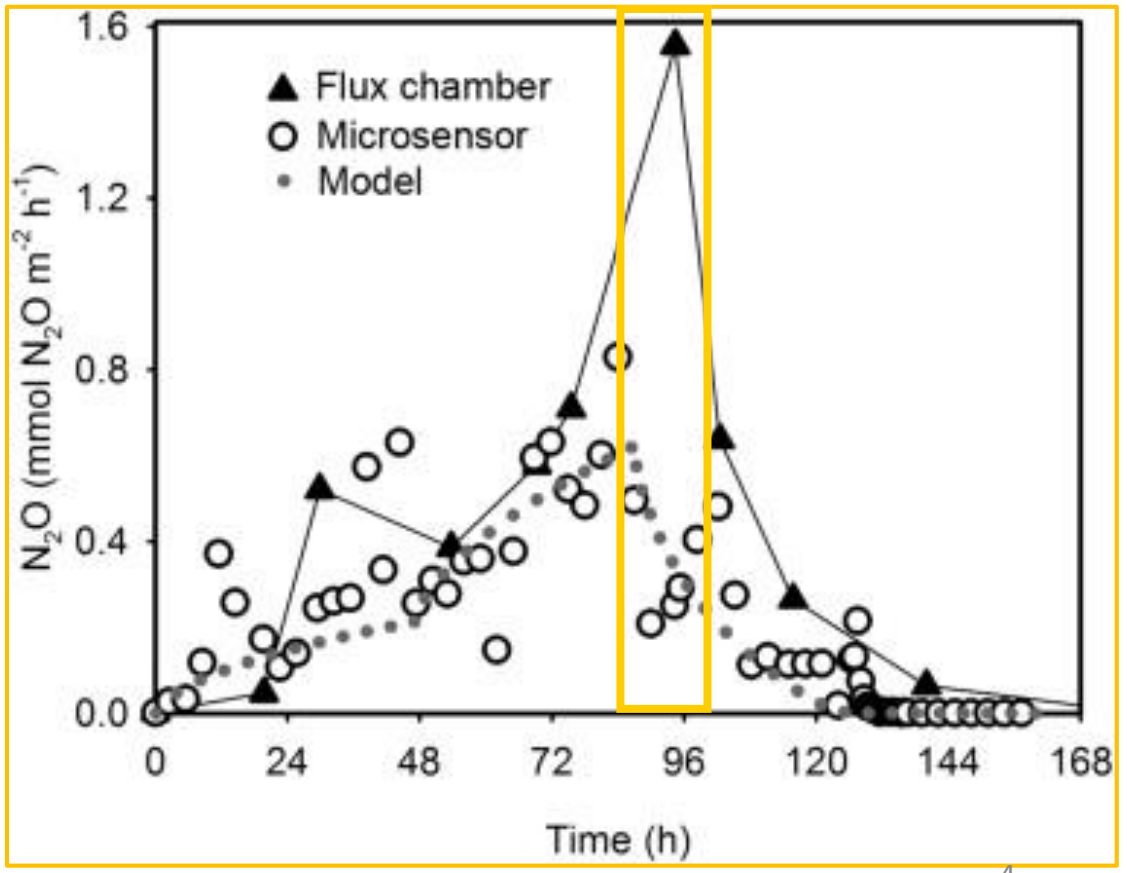
N_2O fluxes vary over space and time

HOTSPOTS + HOT MOMENTS = HETEROGENEOUS EMISSIONS

(big pain to quantify with low uncertainty)



Cowan *et al.* (2017)



Liengaard *et al.* (2014)

How best can we estimate N_2O emissions from an intensively grazed pasture?

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Eddy Covariance

Integrates high frequency field scale N_2O fluxes over a large area and multiple sources ☺

BUT

Can't disaggregate between sources ☹

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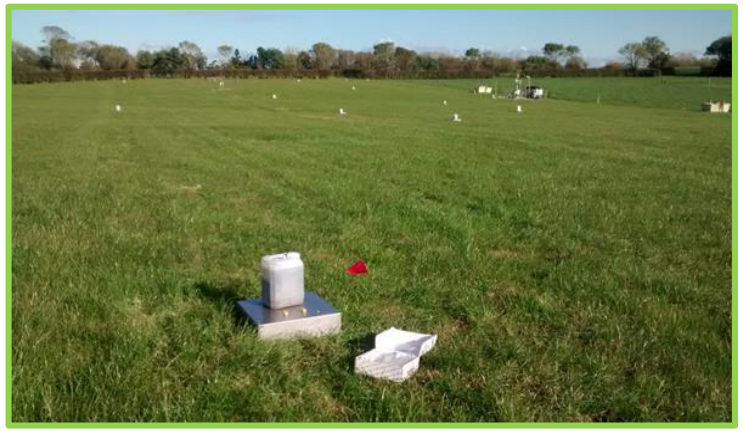

Investigating treatment effects on N_2O emissions ☺

BUT

Limited spatial and temporal resolution which means high uncertainties ☹

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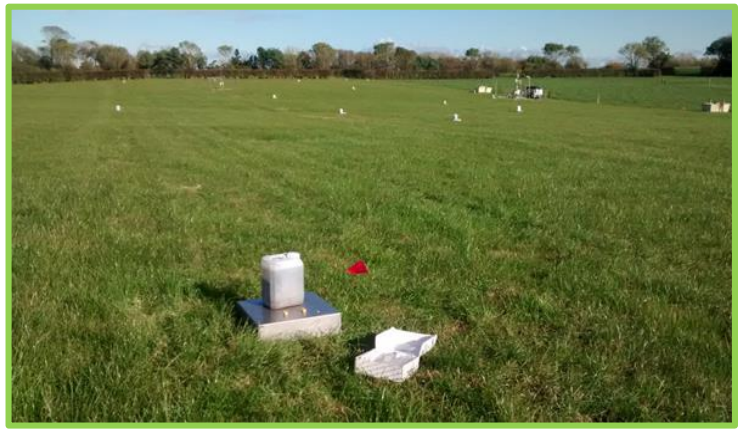

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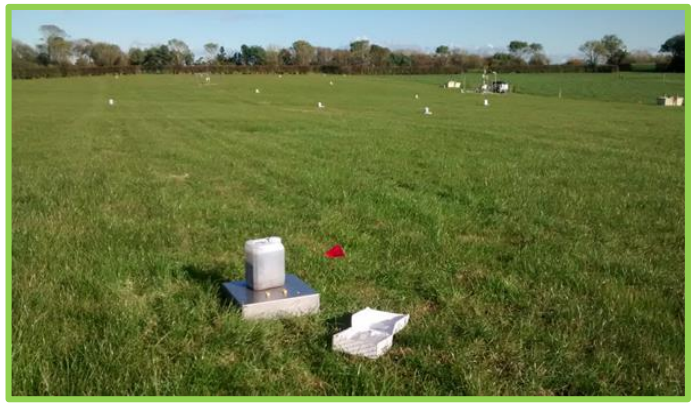
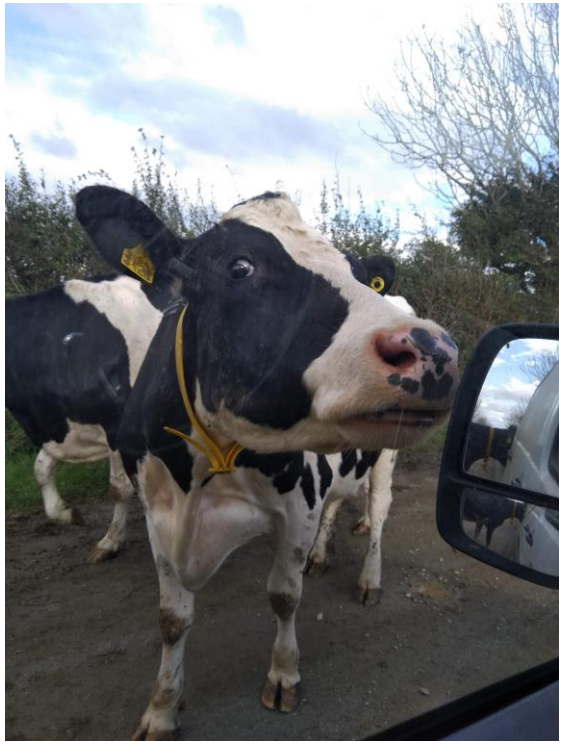
+



Management

6 fertilizer events

9 grazing events



Date	Management	Application date	Application rate		
			kg N ha^{-1}		
			CAN	SU	Dung
04/02/2020 - 10/02/2020	Grazing	-	-	-	-
03/03/2020 - 20/03/2020	Grazing×	03/03/2020	-	517	551
02/04/2020	Fertilizer×	02/04/2020	50	-	-
10/04/2020 - 18/04/2020	Grazing	-	-	-	-
03/05/2020-10/05/2020	Grazing×	04/05/2020	-	517	559
11/05/2020	Fertilizer×	11/05/2020	40	-	-
25/05/2020-03/06/2020	Grazing×	25/05/2020	-	517	405
03/06/2020	Fertilizer×	03/06/2020	27	-	-
17/06/2020 - 24/06/2020	Grazing	-	-	-	-
29/06/2020	Fertilizer	-	20	-	-
09/07/2020 - 18/07/2020	Grazing	-	-	-	-
01/08/2020 -12/08/2020	Grazing	-	-	-	-
14/08/2020	Fertilizer	-	27	-	-
31/08/2020 - 21/09/2020	Grazing×	01/09/2020	-	542	355
14/09/2020	Fertilizer×	14/09/2020	27	-	-

Methods: Eddy Covariance

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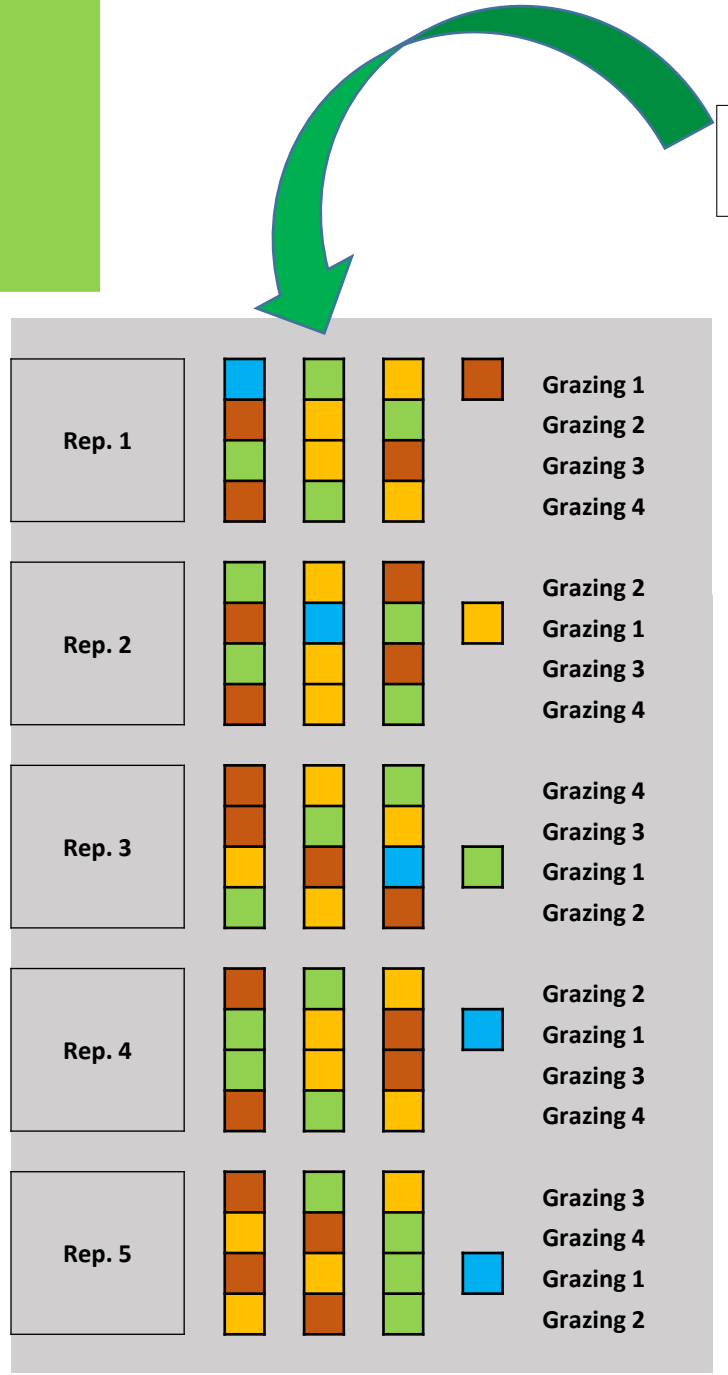
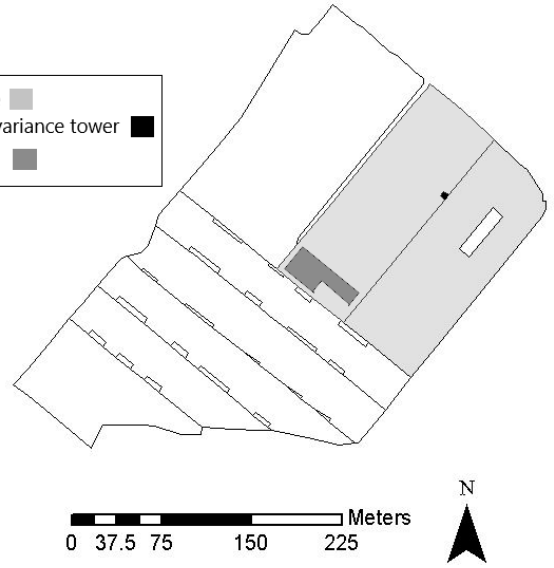
Methods: Static Chambers

Treatments

- 5 replicates per treatment per grazing
  - **Control** (5 reps/exp)
  - **Calcium ammonium nitrate (CAN)**
  - **Dung + CAN**
    - Dung was applied at 2 kg within a 30 cm diameter area
  - **Synthetic urine (SU) + CAN**
    - SU applied at 1.8 L

- Randomized block design
  - 1.5 m between treatments
  - SU and dung applied when cows were in the SW of paddock
  - CAN applied following field application





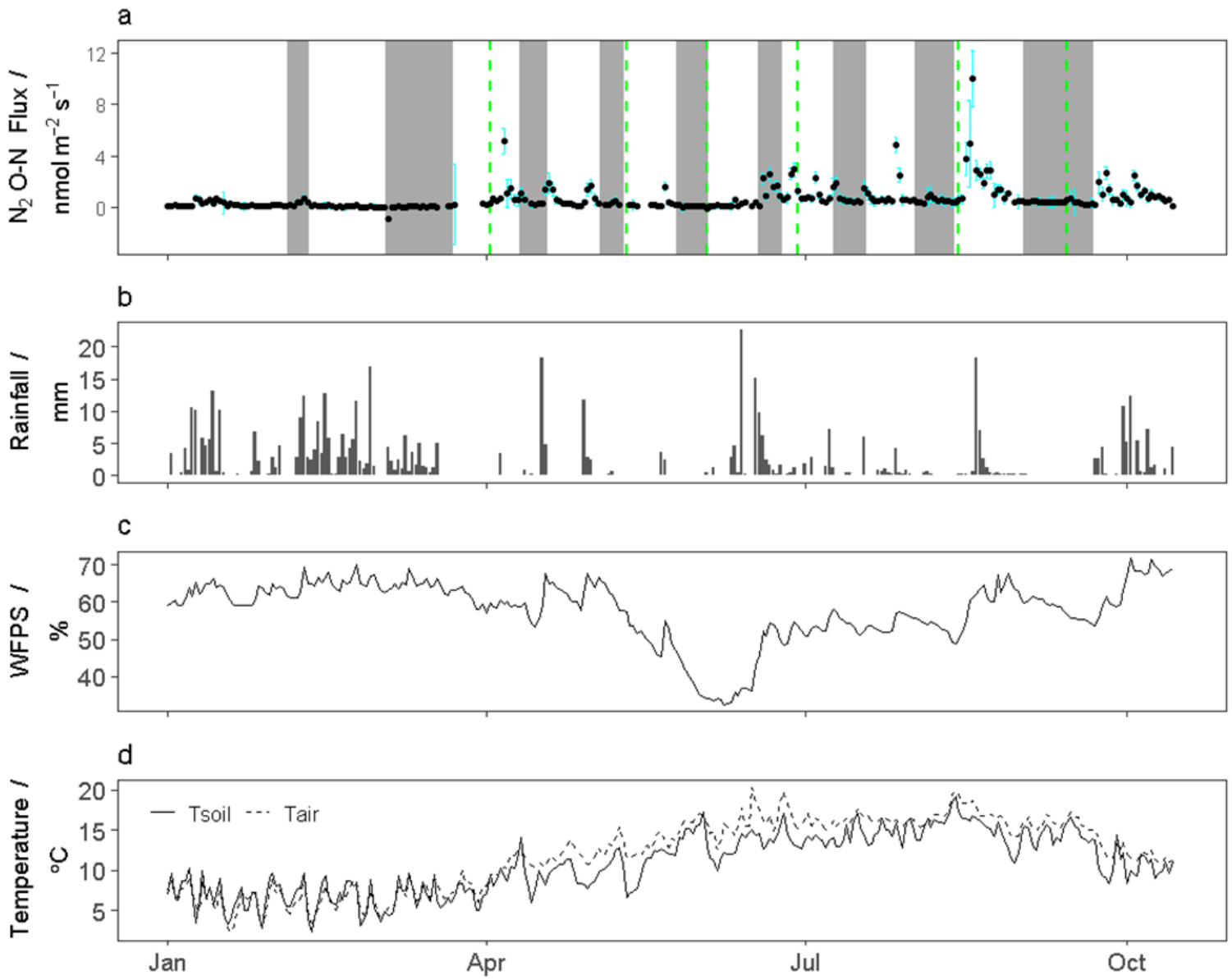
Results

Management:

- **Grey blocks** – grazing
- Green dashed line – fertilizer

Significant correlations with N_2O ($p < 0.05$)

- WFPS
  - Feb, March, April, June, July
- Rainfall
  - Feb, March, May, July
- Soil temperature
  - Feb, March



Results

Grazing	Partial N_2O-N EF					
	CAN		SU+CAN		Dung+CAN	
	%	95% C.I.	%	95% C.I.	%	95% C.I.
1	5.58	2.70	1.28	0.31	0.38	0.14
2	1.60	0.14	0.28	0.06	1.01	0.24
3	2.22	0.57	0.30	0.04	0.30	0.06
4	1.73	0.18	0.49	0.06	0.87	0.16
Mean	**2.78**	**0.90**	**0.59**	**0.12**	**0.64**	**0.15**

CAN > dung+CAN > SU+CAN

Results

Management:

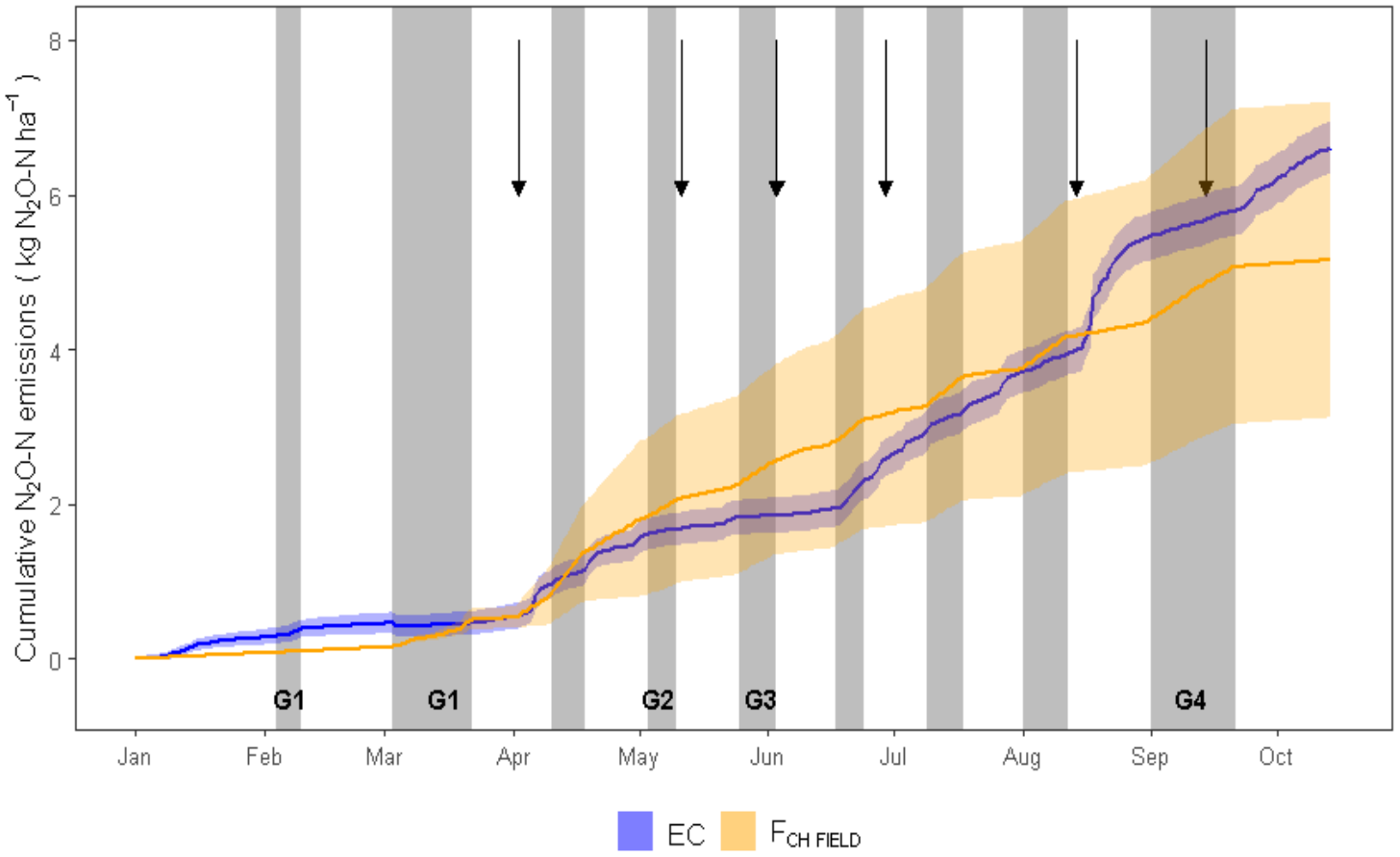
- **Grey blocks** – grazing
- ⬇ – fertilizer

EC

- 6.62 ± 0.33 kg N ha^{-1}
- 0.96 %

EF-derived chamber field flux (F_{CH_FIELD})

- 5.16 ± 2.04kg N ha^{-1}
- 0.72%



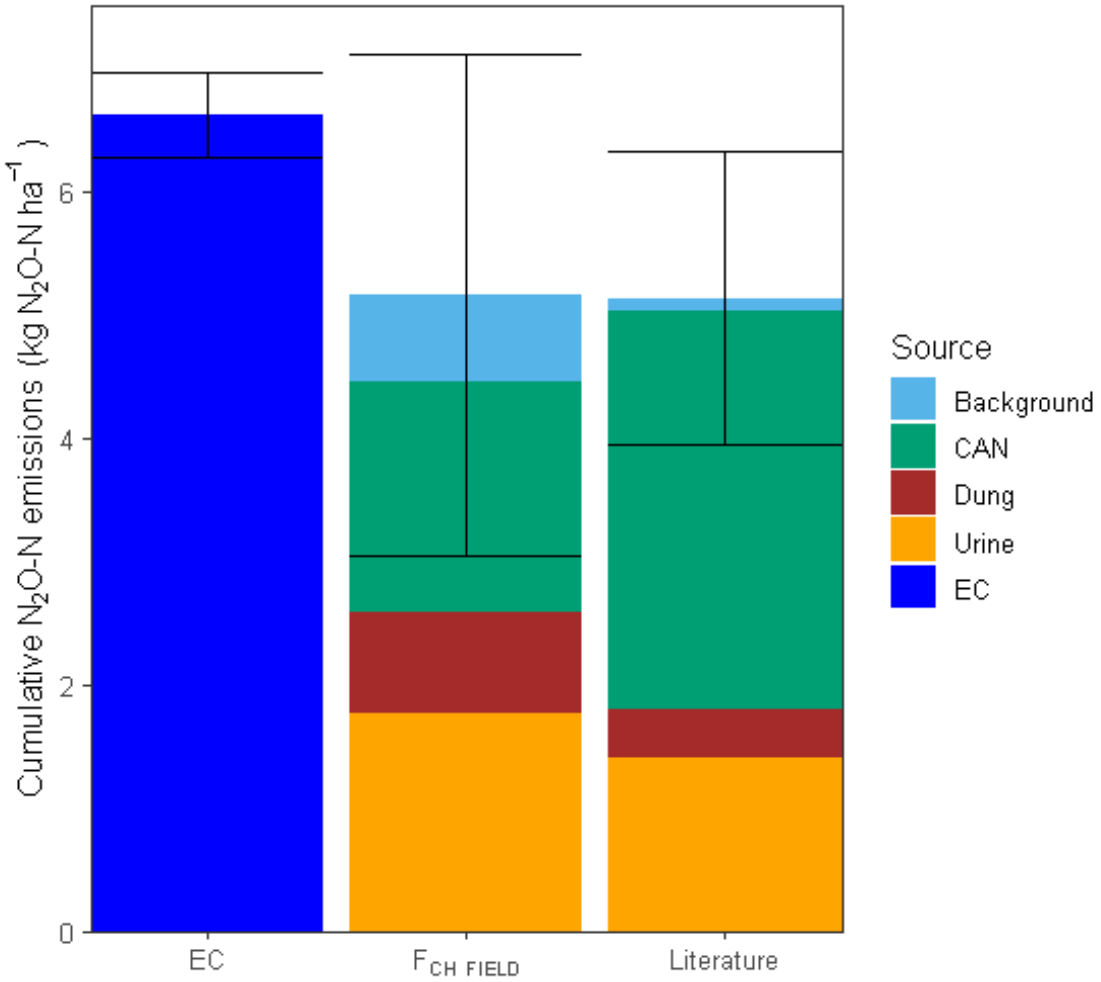
Results

Background : 14%

CAN: 36%

Dung: 16%

Urine: 34%



Author	Treatment	EF		N applied to field	Cumulative N_2O-N flux	
		%	95%.CI	kg N ha^{-1}	kg N ha^{-1}	95% C.I.
Krol et al. 2017	Background	-	-	-	0.11	-
Harty et al. 2016	CAN	1.49	0.71	191	2.85	1.36
Krol et al. 2016	Dung	0.38	0.31	125	0.39	0.31
Marie et al. 2020	Urine	0.47	0.10	299	1.41	0.50

Conclusions

- The EC technique provided spatially and temporally robust annual estimates of N_2O emissions while high uncertainties in emission factor derived chamber cumulative flux estimates were observed.

- Using EC and static chambers in a complimentary fashion can provide more certain and informative estimates of N_2O-N fluxes at the field scale

- By disaggregating field N_2O-N emissions by source, appropriate mitigation strategies for grazing systems can be developed and implemented

Thank you for your attention!

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