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DGO 3

Herd position habits can bias net CO_2 ecosystem exchange estimates in free range grazed pastures

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Introduction

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$$NEE_{tot} = NEE_{past} + R_{cows}$$

NEE_{past}

Livestock respiration (R_{cows})

Methane (F_{CH4-C})

GPP

ER

Manure

Hay, silage

Feeds

Grazing

Meat

Excretions

Carbon leaching

Carbon storage in soil

$$\rightarrow NBP = NEE_{tot} + F_{CH4-C} + F_{manure} + F_{import} + F_{harvest} + F_{product} + F_{leach}$$

Introduction

$$NEE_{tot} = NEE_{past} + R_{cows}$$

$$R_{cows} \approx NEE_{tot}$$

Same order of magnitude !!

Dorinne Terrestrial Observatory

- Annual stocking rate ≈ **2.3 LU ha^{-1} yr^{-1}**
- Continuously grazed pasture

Introduction

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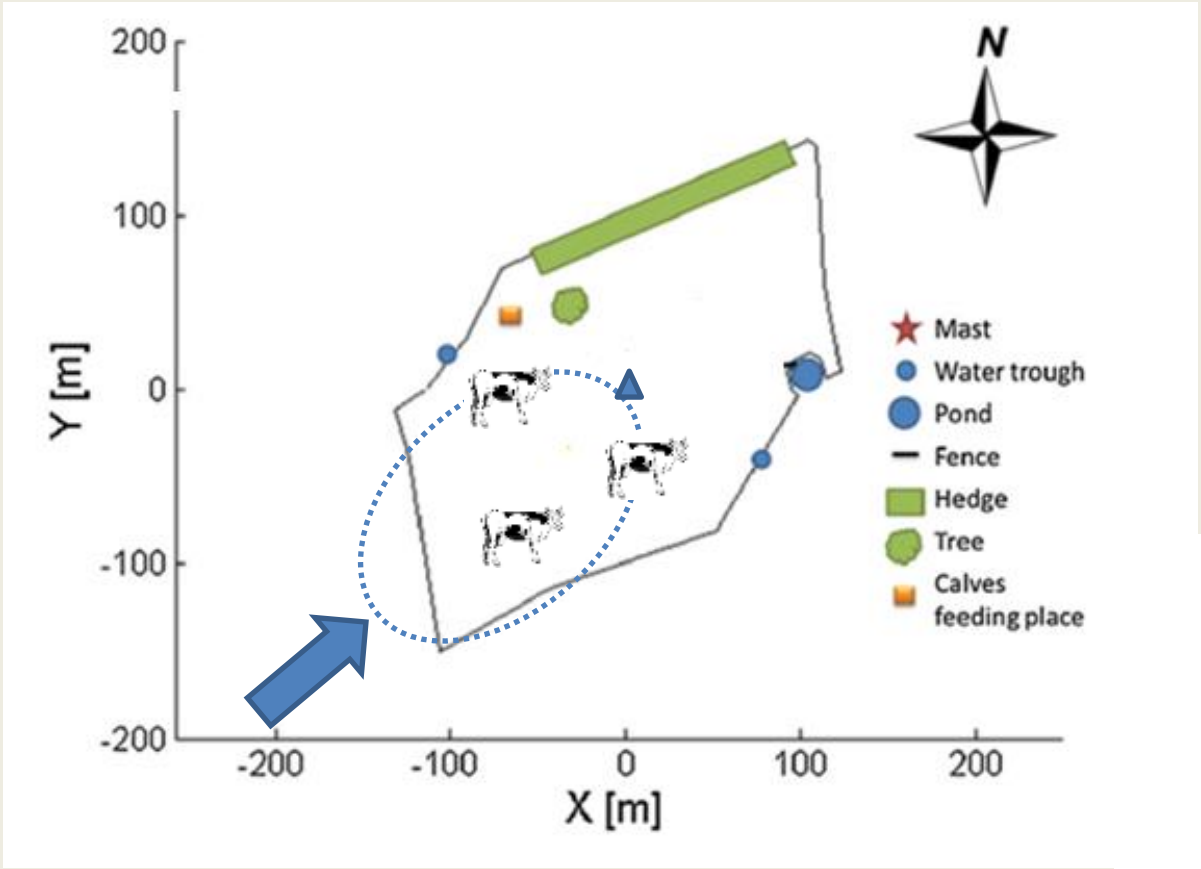
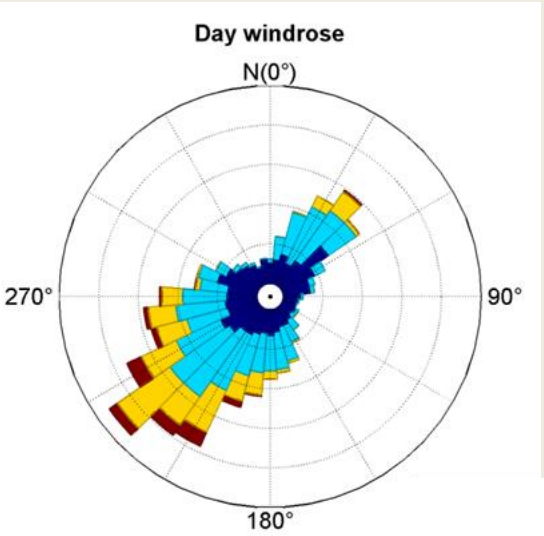
Dorinne Terrestrial Observatory : a free range continuously grazed pasture





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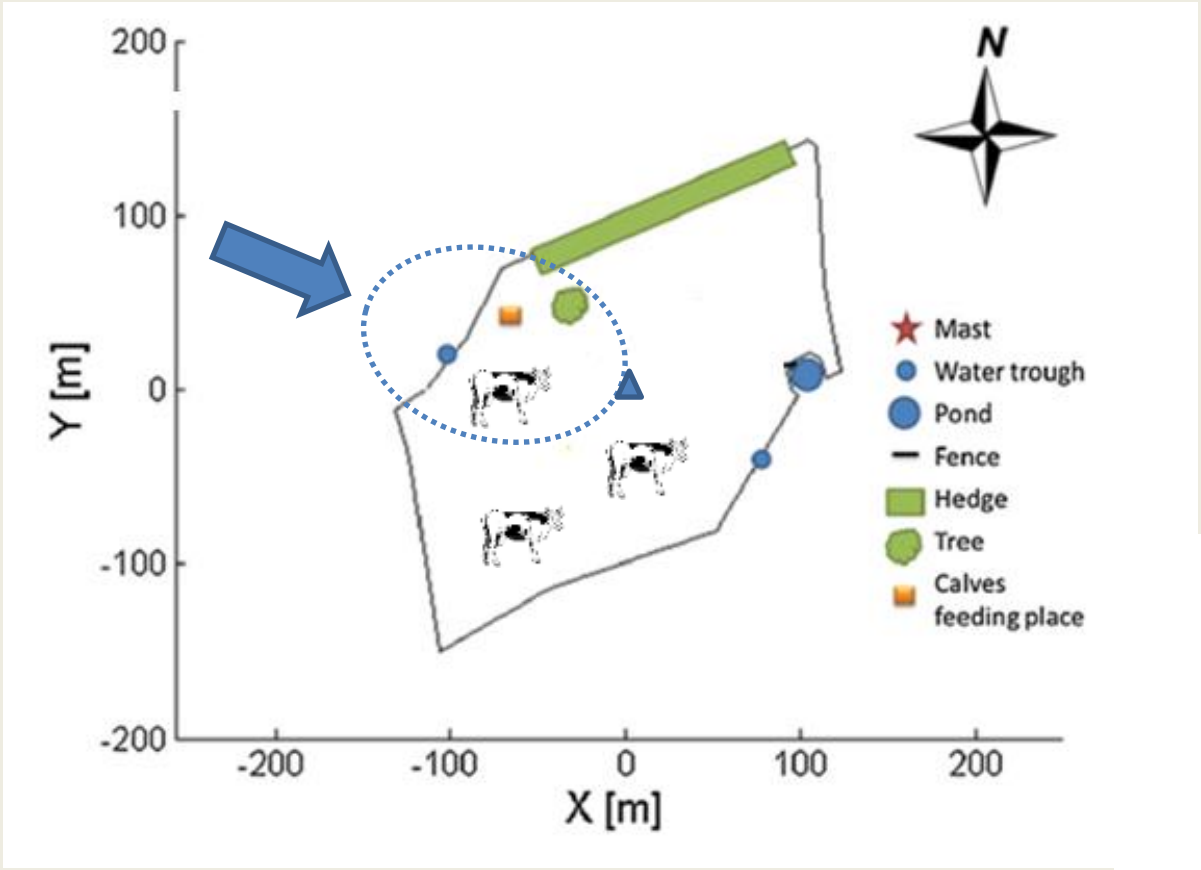

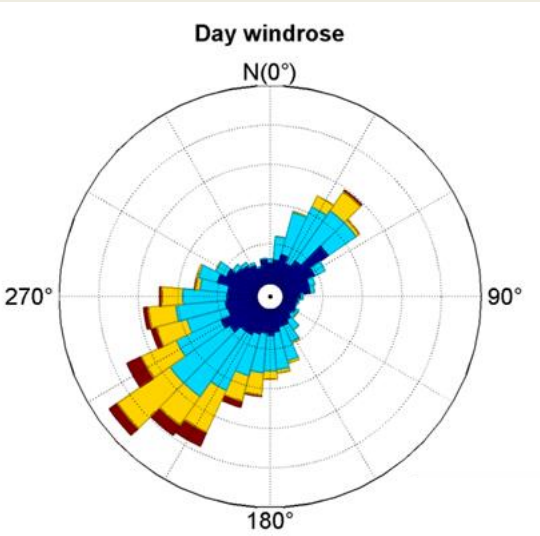

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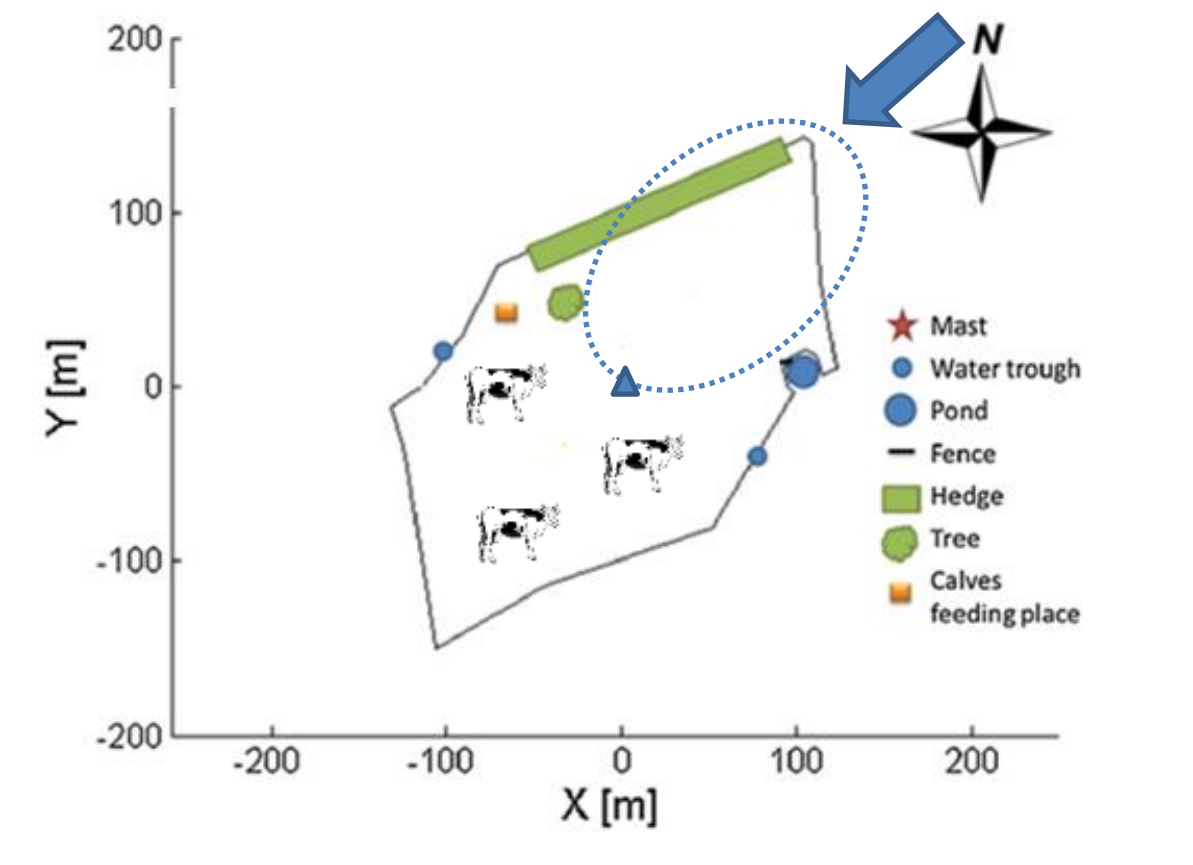

→ Over one year, animal respiration is measured in a representative way only if cows are **homogeneously distributed** over the field (on average)

→ GPS campaigns

Problem ?

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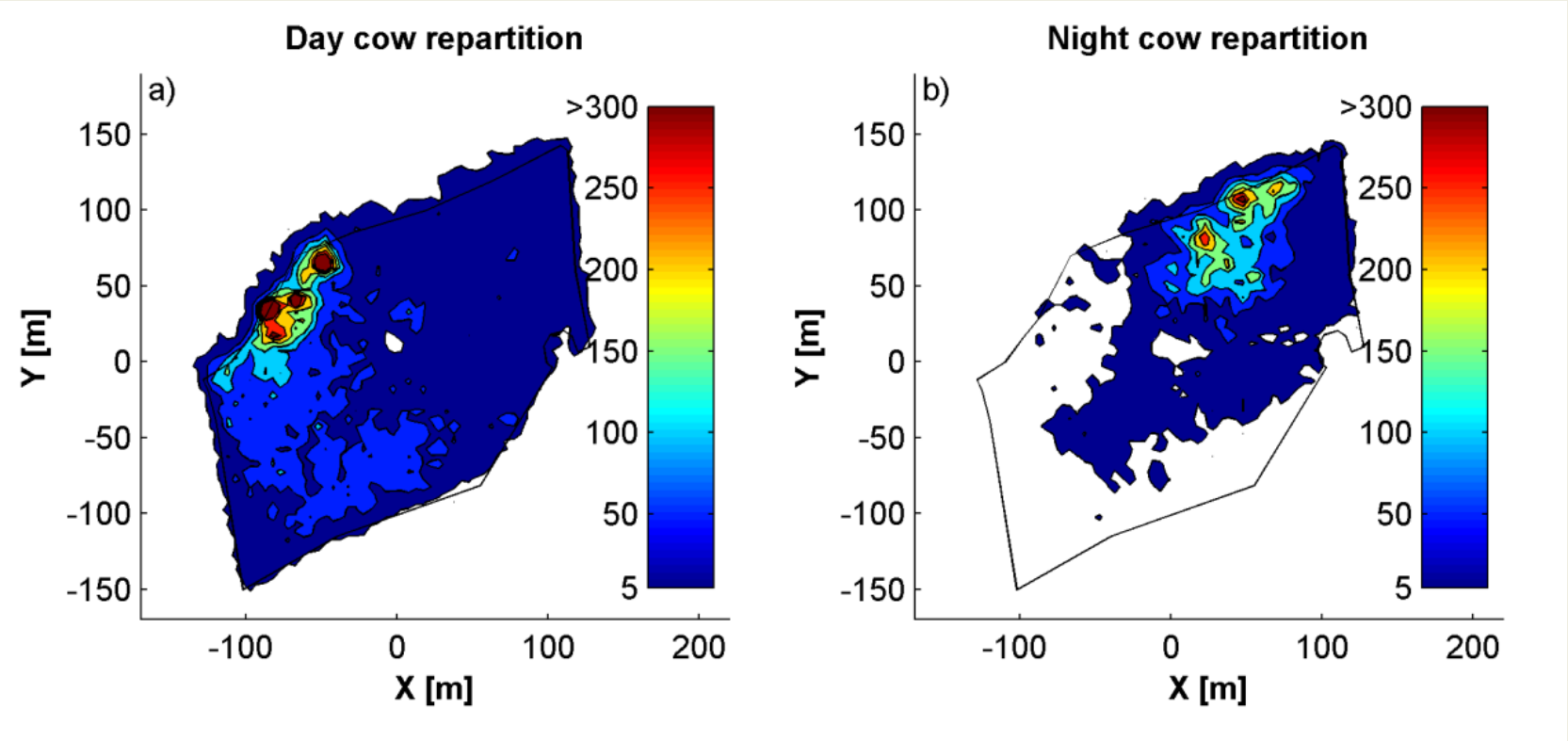
Cow repartition from GPS campaigns



Main wind direction is **South-West**

How does it affect cow respiration and the C budget ?

Method

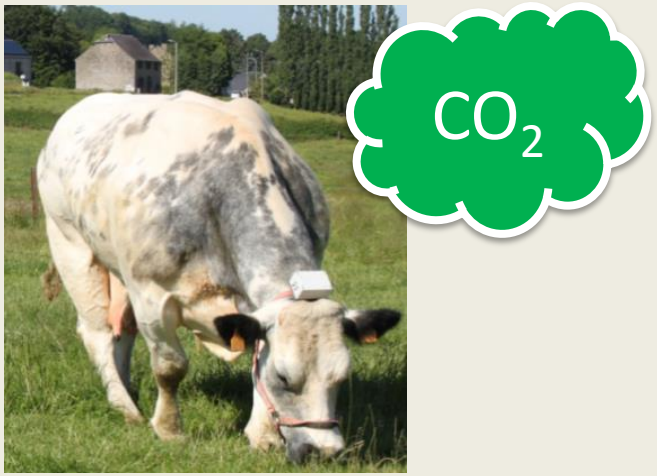
Comparison of cow respiration rates per animal

$$E_{cow,hom} \quad \begin{matrix} < \\ > \\ = \end{matrix} \quad E_{cow,ref}$$

Homogenous cow distribution

?

Reference respiration rate

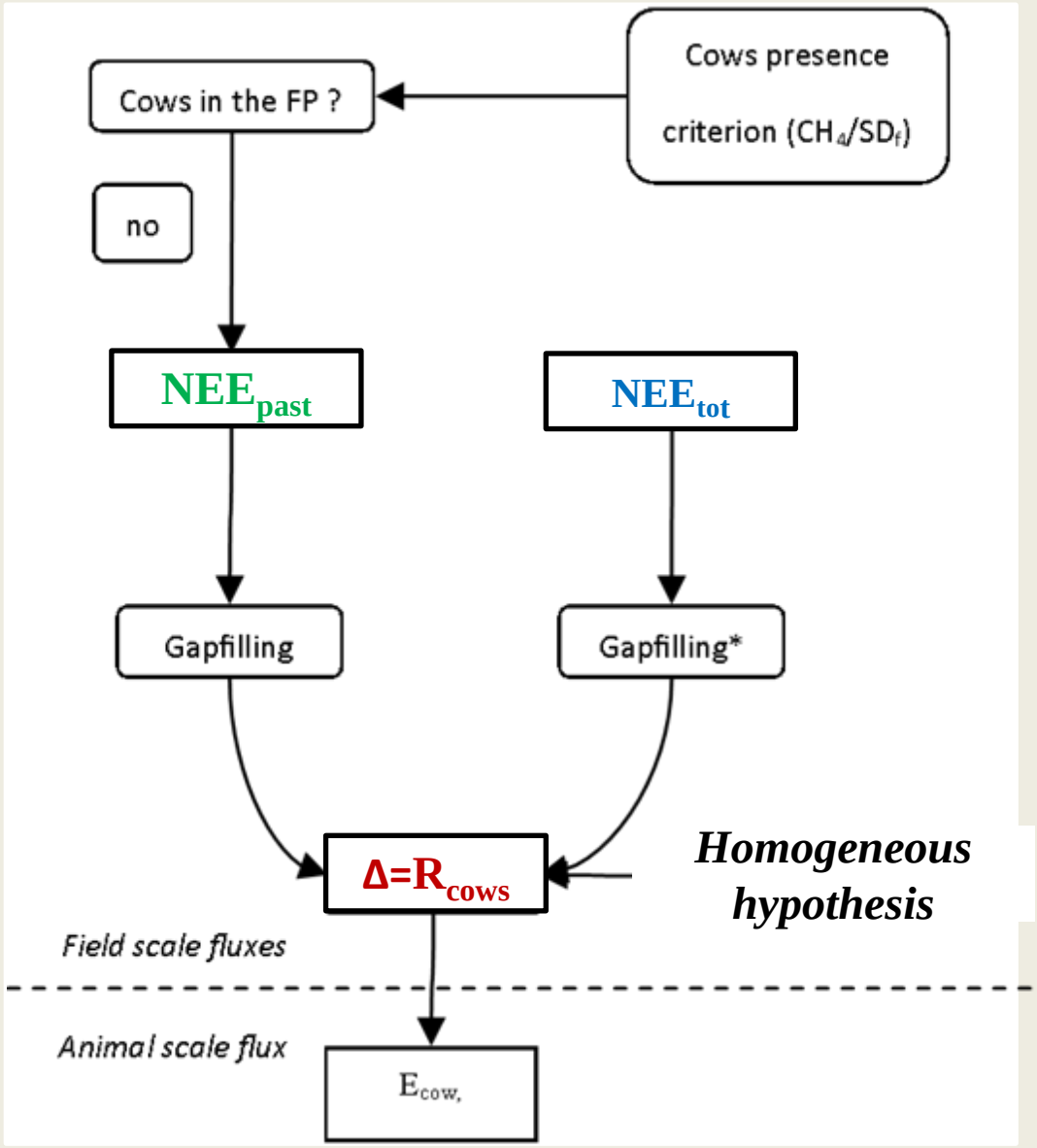


Method

$E_{cow,hom}$

- We use EC **CH_4 fluxes** as a cow presence criterion.
- We can do the partioning between :

$NEE_{tot} = NEE_{past} + R_{cows}$



Method

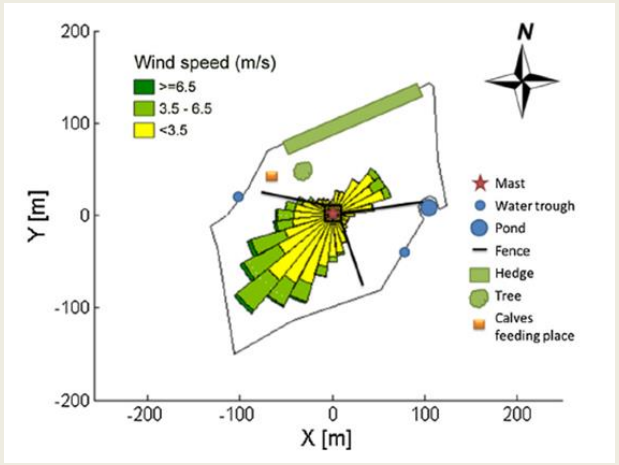
$$E_{cow,ref}$$

GPS campaigns
+ footprint model

$$E_{cow,GPS}$$

Cf : *Felber et al.*, 2016

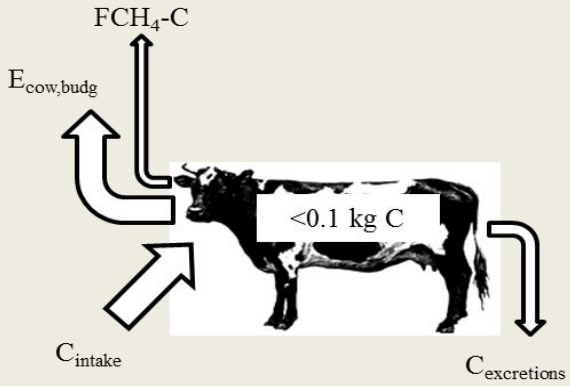
Confinement experiments



$$E_{cow,conf}$$

Cf : *Jérôme et al.*, 2014

Animal scale C budget
+ digestibility



$$E_{cow,budg}$$

Cf : *Gourlez de la Motte.*, 2016

Results : Paritioniong

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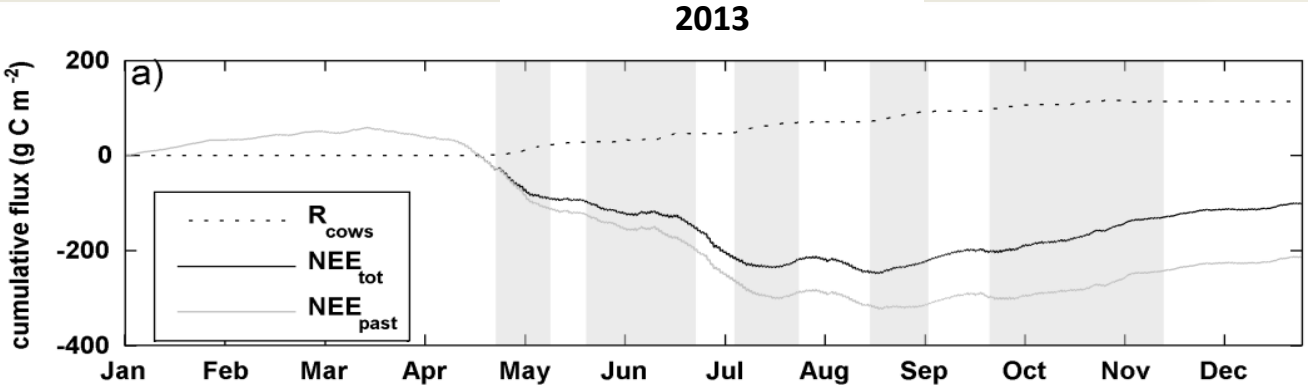
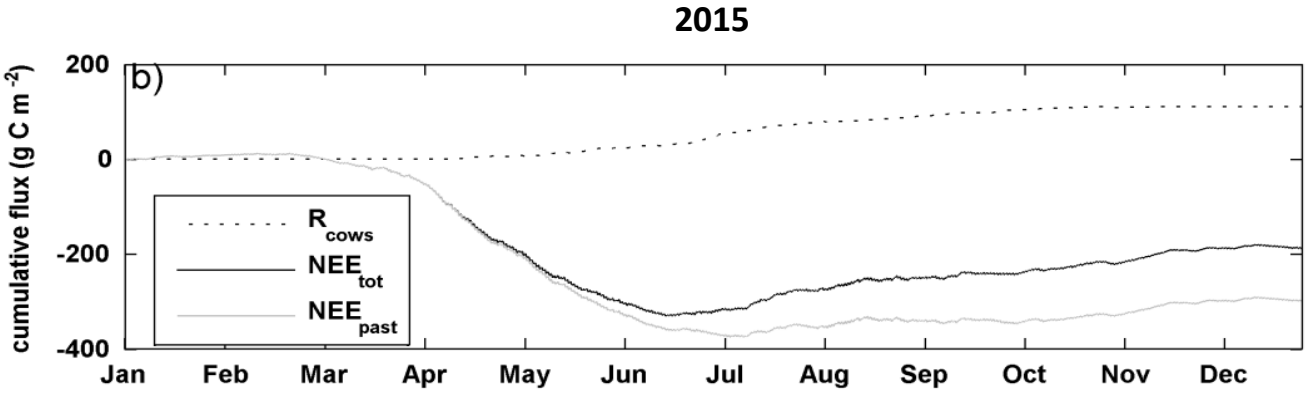
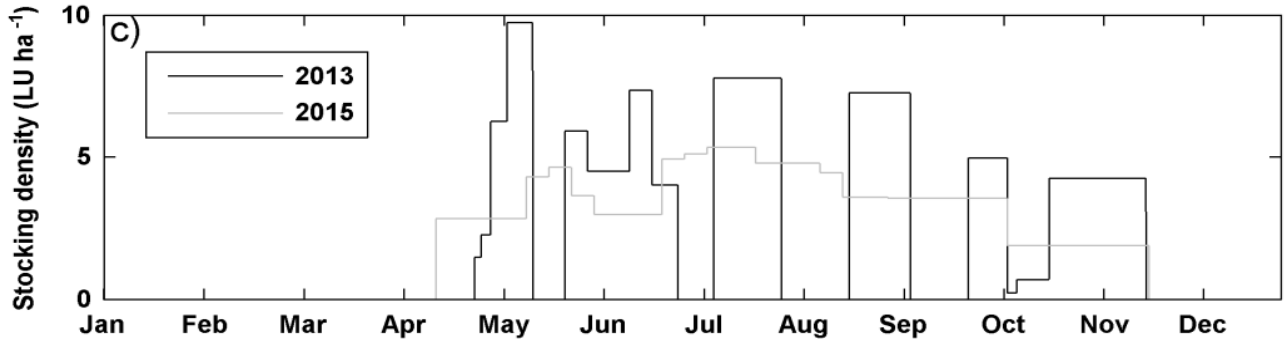






Annual values 2013:

NEE_{tot} = –102 g C m^{-2} yr^{-1}

NEE_{past} = –214 g C m^{-2} yr^{-1}

R_{cows} = 112 g C m^{-2} yr^{-1}

Annual values 2015:

NEE_{tot} = –188 g C m^{-2} yr^{-1}

NEE_{past} = –299 g C m^{-2} yr^{-1}

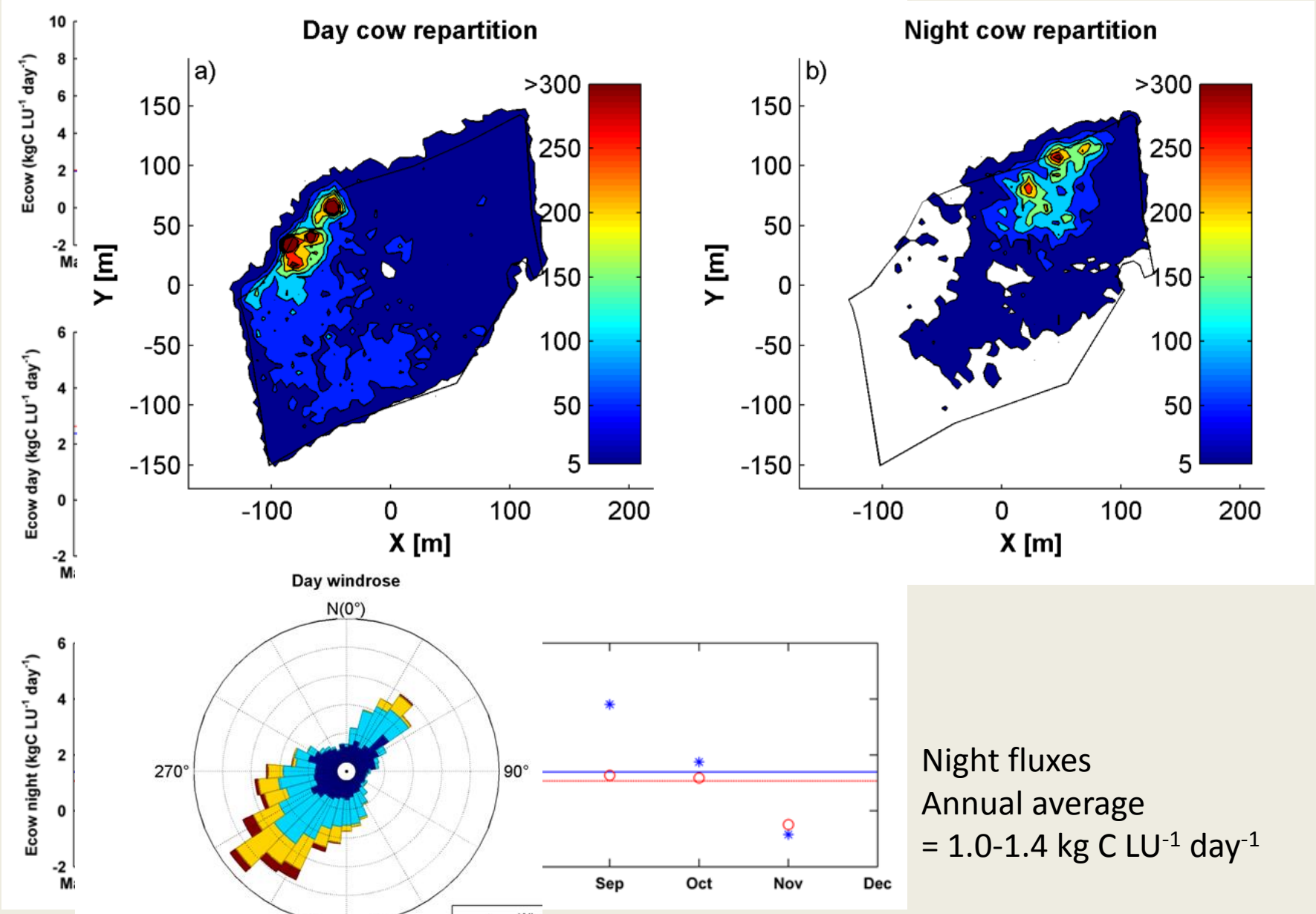
R_{cows} = 111 g C m^{-2} yr^{-1}

Annual stocking rates :

2013 : 2.1 LU ha^{-1} yr^{-1}

2015 : 2.2 LU ha^{-1} yr^{-1}

Results : $E_{cow,hom}$



Night fluxes
Annual average
= 1.0-1.4 kg C LU^{-1} day^{-1}

Results : $E_{cow,ref}$

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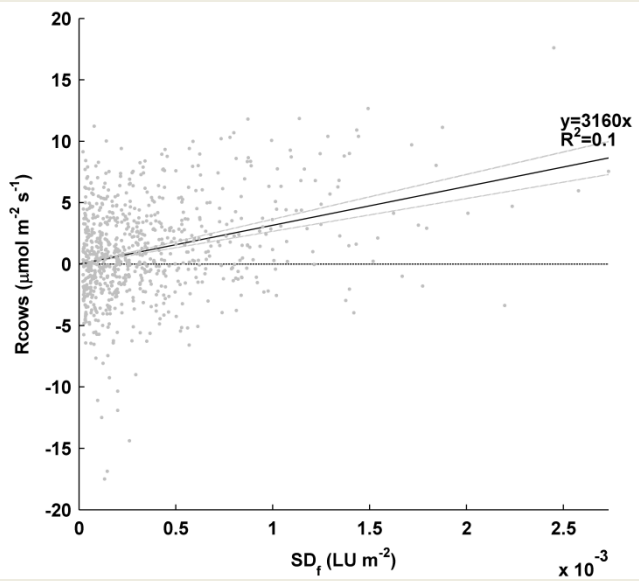
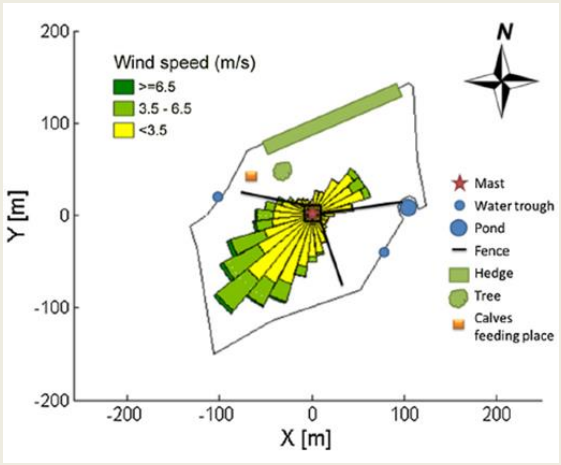
GPS campaigns + footprint model



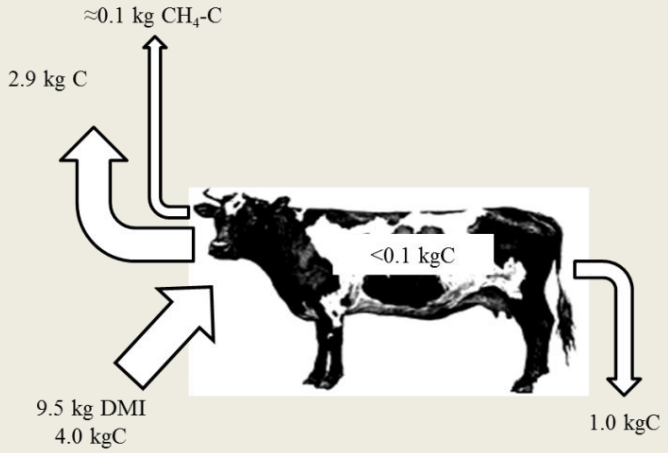
$E_{cow,GPS}$
= 3.2 ± 0.6 kg C LU^{-1} day^{-1}

Confinement experiments



$E_{cow,conf}$
= 3.6 ± 0.6 kg C LU^{-1} day^{-1}

Animal scale C budget



$E_{cow,budg}$
= 2.9 kg C LU^{-1} day^{-1}

Results : to summarize…

	2013	2015
Footprint %	68%	69%
SD_p (LU ha^{-1})	1.4	1.5
Animal scale fluxes (kg C LU^{-1} d^{-1})		
a) Homogeneous cow repartition hypothesis		
$E_{cow,hom}$	**2.0 ± 0.6**	**2.0 ± 0.6**
$E_{cow,hom,day}$	2.4	2.6
$E_{cow,hom,night}$	1.4	1.0
b) No homogeneous cow repartition hypothesis		
$E_{cow,GPS}$	**3.2 ± 0.5**	
$E_{cow,conf}$	**3.6 ± 0.6**	
$E_{cow,budg}$	**2.9**	
Field scale fluxes (g C m^{-2} yr^{-1})		
$R_{cows,hom}$	112 ± 20	111 ± 28
$R_{cows,GPS}$	164 ± 41	175 ± 44
Bias (absolute value)	52	64

$$E_{cow,hom} < E_{cow,ref}$$

At our site, annual cow respiration is **underestimated** of

≈ 60 g C m^{-2} yr^{-1}

NBP before correction : -161 g C m^{-2} yr^{-1}

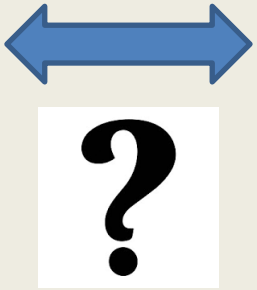
NBP after correction : -100 g C m^{-2} yr^{-1}

The magnitude and sign of the bias is of course site specific !!

Implications for grassland studies…

Mown meadows

Grazed pastures



$NEE_{tot} = NEE_{past}$

$NEE_{tot} = NEE_{past} + R_{cows}$

- This study also highlight the lack of consistency between studies when communicating annual NEE values

→ Ideally, NEE_{past} and R_{cows} should be communicated seperately to improve comparisons

→ Can be done using CH_4 fluxes and/or any other animal localization devices

→ R_{cows} can be computed using one (or more) of the proposed methods

For more details

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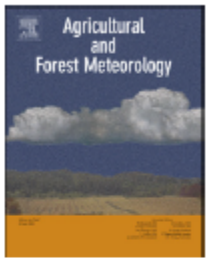

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Thank you !