

Review of the manuscript: bg-2014-104 “The impacts of drainage, nutrient status and management practice on the full carbon balance of grasslands on organic soils in a maritime temperate zone”, F. Renou-Wilson, C. Barry, C. Müller, and D. Wilson

The manuscript represents a profound study of carbon balances and GHG emission in drained organic soils in Ireland, but the significance extends beyond this. The authors have included fluvial C losses in their carbon balances which is seldomly attempted in such studies. Notably the discussion is excellently written and enlightening. I have found a number of smaller issues and edits to be addressed; these are all highlighted in the attached document. My main concerns are related to the daily data coverage which is not explicitly stated, and the focus on only spatial uncertainty (vs modelling uncertainty). Yet, I recommend the publication of the MS with minor revision and hope the included comments will help to improve the MS.

### General comments

It is not clear from the methods description how many times each collar was visited for CO<sub>2</sub> measurements during 8 am to 6 pm on the individual measurement days. This information on data coverage is important and must be included.

It seems somewhat unfortunate to pool all data from each site to derive models for GPP and Reco. This reduces the information on spatial variability, e.g., among the deep and shallow sites. The Reco models applied at site A and B are very different and apparently without any exponential term for temperature response? I think a model like eq.2 usually comes with an exponential term? Note also that parameter b appears twice in eq.2?

A treatment of uncertainties in the annual C balances is missing. How was the effect of uncertainty in modelled response parameters addressed? It seems only spatial uncertainty was addressed (by running the models for individual collars and presenting data as mean and standard deviation).

Generally, details on reported variability are missing or unclear; I have provided suggestions below.

### Abstract

Introduce abbreviation GHG at first mention (line 4, rather than line 9)

Line 13 and 14: confusing to report C per m<sup>2</sup> and N<sub>2</sub>O per ha; I suggest to change units and unify area

Line 13: spell out net ecosystem exchange, NEE, at this first mention in abstract

Line 13: in information like (NEE 233 g C m<sup>-2</sup> yr<sup>-1</sup>) I suggest to introduce a comma for clarity, i.e., (NEE, 233 g C m<sup>-2</sup> yr<sup>-1</sup>). This applies throughout the manuscript.

Line 16: suggest not to use ‘+’ at occasional instances

## Introduction

Line 20 (p 5559): maybe use 'year' rather than 'annum'

Line 12-13 (p 5561): I guess biomass C export should also be included here in the elements mentioned for calculation of NECB?

## Materials and methods

Line 8 (p 5562): (annual runoff, c. 586 mm) rather than just (c. 586 mm)

Line 22 (p 5562): IPCC citation should be 2014 rather than 2013

Line 9 (p 5563): *Holcus lanatus*

Line 16 (p 5563): '...each collar...' change to '...each collar for GHG measurements (see below)...'

Line 1 (p 5564): define PPFD at first mention here (rather than p 5564, line 23); is PPFD used here as equivalent to PAR then PAR can be replaced (p 5563, line 26)

Line 2-4 (p 5564): why are linear regressions used to develop site specific relationships, when data in Fig. 1 are shown with fitted cubic regressions? Indeed, it seems inappropriate to use linear regressions through the origin to fit to data in Fig. 1?

Line 5-9 (p 5564): it seems these 5 line rather belong to the next subheading on 'Greenhouse gas measurements'

Line 11-12 (p 5564): ( $n = 7$  for site  $A_d$ ,  $n = 5$  for site  $A_s$ )

Line 21-24 (p 5564): so you had two series of soil temperature recordings at 5 and 10 cm?

Line 1 (p 5565): '...chamber method (Alm et al., 2007), between 8 a.m. and 6 p.m.' change to '...chamber method (Alm et al., 2007). Measurements were done between 8 a.m. and 6 p.m.'

Line 1-2 (p 5565): no need to define NEE again and no need to give units of PPFD again

Line 9 (p 5565): (PP Systems. UK). Change to (PP Systems, UK).

Line 22-28 (p 5565): I appreciate the consideration of low fluxes which are valid even though  $r^2$  is not high. Indeed  $r^2$  is not a good quality indicator of robust fluxes (see e.g. Görres et al. (2014) *Agriculture, Ecosystems and Environment* 186: 64–76.)

Line 4 (p 5566): stick to 'fortnightly' rather than 'biweekly' (which can also mean twice a week)

Line 7-9 (p 5566): 'Four 50mL samples were withdrawn into 60mL polypropylene syringes from the chamber headspace at 10 min intervals over a 40 min period and then injected...' This is a little ambiguous as samples taken over a 40 min period at intervals of 10 min would amount to 5, rather than 4, samples. Does this imply that no  $t=0$  measurements were taken? Please clarify.

Line 9 (p 5566): I guess you used Exetainers®; this could be specified as these come with stoppers known to withstand storage of sampled gases

Line 22-25 (p 5566): what is the reason for being more strict on  $r > 0.90$  when it comes to CH<sub>4</sub> and N<sub>2</sub>O fluxes? The situation is analogous to the CO<sub>2</sub> fluxes, and you risks to discard a number of valid, but low fluxes.

Line 22 (p 5567): do you mean (see Sect. 2.2) ?

Line 1: delete 'in the soil'

Line 2: WT already defined; just use WT

Eq. 2 (p 5568): parameter occurs twice? Change T to  $T_{5cm}$

Line 6 (p 5568): delete degree sign in front of K

Line 12 (p 5569): NEE already defined

## Results

Line 23-44 (p 5570): 'In Year 2, Site A received similar to Year 1, above long-term average precipitation (1193 mm) driven by high values during June and July, September and October, and December and January. Both the mean...' suggest to rephrase to 'In Year 2, Site A again received higher precipitation than the long-term average (1193 mm) driven by high values during June and July, September and October, and December and January. However, both the mean...'

Line 5-6 (p 5571). It seems from Fig. 2 that cumulative Y1 and Y2 PPDF are very similar, so is your statement correct?

Line 18-20 (p 5571). The model coefficients for R-eco cannot be compared as they are part of two very different models, so rephrase this sentence.

Line 26-27 (p 5571): this qualitative statement could easily be backed up by statistics

Line 4-7 (p 5572): Again, statistics of bias is recommended

Line 27 (p 5572): change 'a-1' to 'yr-1'

Line 5-8 (p 5574): Clarify. '...the highest amount at 265 (27) kg N ha<sup>-1</sup> yr<sup>-1</sup> compared to 107 (45) and 80 (12) kg N ha<sup>-1</sup> yr<sup>-1</sup> in Site Ad and Site As. N biomass exports were 17 to 19% lower in Year 2 in Site Ad and As respectively.'

E.g.,:

'...the highest amount at 265 ( $\pm 27$ ) kg N ha<sup>-1</sup> yr<sup>-1</sup> compared to 107 ( $\pm 45$ ) and 80 ( $\pm 12$ ) kg N ha<sup>-1</sup> yr<sup>-1</sup> in Site Ad and Site As (data are mean  $\pm$  standard deviation with  $n = 7$  for Site Ad and  $n = 5$  for site As). Compared to Year 1, N biomass exports were 17 to 19% lower in Year 2 in Site Ad and As respectively.'

Line 12-13 (p 5574): I see no high emission in November ?

Line 19-21 (p 5574): reading this sentence is rather confusing: 'Annual CH<sub>4</sub>-C emissions differed between years with higher values (1.3 $\pm$ 1.09 g CH<sub>4</sub>-C m<sup>-2</sup> yr<sup>-1</sup>) observed in Year 1 and lower values (1.4 $\pm$ 1.1 g CH<sub>4</sub>-C m<sup>-2</sup> yr<sup>-1</sup>) in Year 2 (Table 4).' How is it 1.3 ends up as a higher value than 1.4? I would rather say the values are identical. Also, again, the basis of the used statistics on variability should be clearly stated.

Line 24-25 (p 5574): keep consistency and cite as Year 1 and 2

Line 7 (p 5575): delete '.' in parentheses

Line 8 (p 5575): I suggest to use same area unit as for other fluxes, i.e., 0.16 g N<sub>2</sub>O-N ha<sup>-1</sup> yr<sup>-1</sup>

Line 18 and 19 (p 5575): specify that percentages refers to total fluvial C fluxes

Line 15-17 (p 5576): restructure this sentence to more clearly indicate what the basis for variation shown in parentheses represents. This is highly unclear as the numbers are very different from the uncertainties shown in Table 4 ? Also note, that 342 g C m<sup>-2</sup> yr<sup>-1</sup> probably should be 358 g C m<sup>-2</sup> yr<sup>-1</sup> ? Finally, 'g' is presently omitted in line 16.

## Discussion

Line 11 (p 5579): for clarity: (30% more in Year 1 and 35% more in Year 2 compared to site As)

Line 14 (p 5582): 'maybe' change to 'may be'

Line 28-29 (p 5582): '...temperate climate, emitted only in very small amounts when the mean annual water table was around - 23 cm.'

suggest to write ‘...temperate climate, and that CH<sub>4</sub> was emitted only in very small amounts when the mean annual water table was around – 23 cm.’

These data fits well with a number of recent compilations, e.g., Audet et al. (2013) Ecological Indicators 34, 548-559.

Line 4 (p 5583): N<sub>2</sub>O

Line 8 (p 5583): ‘(closer to the IPCC default values for nutrient rich shallow drained).’ This is a little insider style: Include mentioning the soil type .

Line 3-4 (p 5586): subheading: ‘4.5 Implications for reporting and climate change mitigation strategies CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O and DOC emission factors’ ; please rephrase for clarity

Line 16-17 (p 5586): suggest not to use ‘+’ at occasional instances

## Tables

Table 1:

Table heading: change ‘...from both locations...’ to ‘...from the two research locations...’

The data entries are not aligned with the years; move all data down one row

Table 2:

State the data source of Table 2, so methods can be evaluated. E.g., related to LOI-to-OM conversion and OM-to-C conversion if C was not measured directly

NH<sub>4</sub><sup>+</sup>N rather than NH<sub>4</sub>N or is typing intended to be NH<sub>4</sub>-N?

Table 3:

heading: insert ‘and’ between (GPP) and ecosystem respiration. Put Reco in parentheses.

What about T<sub>0</sub> from eq. 2? Was that modelled or assumed to a fixed value; please specify.

Further, in the text r<sup>2</sup>= 0.85 is mentioned for GPP model at Site B (p 5571, line 26) – should this be the correct R<sup>2</sup> to include in the Table (rather than 0.72) ?

Table 4:

As done for NECB, the other parameters should be spelled out. State the basis for the SD and SE values, i.e., specify *n* and that they represent the spatial uncertainty. NECB Site Ad sums to 358 rather than 342.

## Figures

Figure 2: panel identifier (a) is missing from upper panel. Note umol rather than μmol on y-axis, panel A.

Caption: delete ‘(a)’ in front of PPF<sub>D</sub>. Maybe write PPF<sub>D</sub> in full text in the figure caption

Figure 3: specify what error bars in panel a represent. At what depth were VMC measured and are the low contents in May believed to be real? Maybe you could have included precipitation data to substantiate the dynamics.

Figure 4: I suggest to spell out Reco and GPP in the figure caption. Has the accordance between data and 1:1 lines been tested? And just a detail, h-1 is used in caption whereas hr-1 is used on axes.

Figure 5: amend y-axes to 'CO<sub>2</sub> flux (g CO<sub>2</sub>-C m<sup>-2</sup>). Figure caption: state the basis for standard deviations (e.g., standard deviation of means for CO<sub>2</sub> fluxes for all collars at a site, i.e., with n = 7 for Site Ad etc...)

Figure 6: I suggest to delete this figure

Figure 7: Again, indicated source of variation.

'...grazing events...' change to '...simulated grazing events (cuttings)...

y-axis: put cm day<sup>-1</sup> in parentheses

Figure 8: amend y-axis to read: 'CH<sub>4</sub> flux (mg CH<sub>4</sub> m<sup>-2</sup> h<sup>-1</sup>)'

Figure 9: cf comment to Fig. 8 and note 'μ' should be used on y-axis. Further the source and amount of fertilizer could be mentioned in the caption

Figure 10: spell out LAI in caption and indicate units on x-axis. Please provide some info on the nature of the points in Fig. 10. I guess each collar is represented 2 times (Year 1 and Year 2) to give 10 and 14 points. But what about LAI; when are the measurement done, or are the data a seasonal average? Please specify.