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Interactive comment on "Carbon balance of a restored and cutover raised bog: Comparison to global trends" *by* Michael M. Swenson et al.

Anonymous Referee #1

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What's the paper about: In this ms Swenson et al attempt to estimate C-balance of five managed raised bogs in Ireland. The five sites differ in their hydro-physical and ecological characteristics, as defined by the National Parks and Wildlife Servies of Ireland. The strength of their study is in their attempt to estimate total C-balance of each site based on measurements of various aspects of ecosystem carbon balance during the same season, including: ecosystem CO_2-gas flux, ecosystem CH_4-gas flux, aquatic fluxes of dissolved organic and inorganic carbon and CO_2 gas efflux from open water in drainage ditches. Furthermore, they provide a literature compilation and review of studies that have measured ecosystem CO_2 and methane flux in boreal and temperate, managed and intact, peatlands. They use the global synthesis to explore global patterns between the fluxes and mean annual water table. They discuss their sites

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in light of the global patterns and argue that the most practical advice to policy makers on C-sequestration potential of restored peatlands should involve insights into the impact of water table and vegetation composition on C-fluxes - two aspects that are actually manageable at sites. Some caution should be taken when interpreting their annual sums of different component fluxes, as most are modelled based on point measurements throughout the year and in some cases models were used to extrapolate beyond the data range used to develop the empirical model! Lots of assumptions used in some cases.

Detailed Comments: 1. This is a bit lengthy ms, but given it has a synthesis review, maybe ok for length. Journal can decide if to have it split into ms a and b or one ms when published. ALternatively there may be enough material here to write two separate more focused ms: one using actual observed data, focusing on observed trends and one on estimated/modelled trends in light of the global synthesis work.

2. Title may be worth modifying to include "implications for restoration efforts" in it - or something along the way. Also use of "restored and cutover" is a bit confusing. It sounds like both sites are undergoing restoration, just for different amounts of time. Perhaps reword to be more clear: "raised bogs at different stages of restoration".

3. Keywords: may be add DIC, DOC, global synthesis, carbon balance

4. Abstract - you mention measuring along 5 different ecotypes, but only two are listed. Describe all 5 then. Also reword to include all 5 ecotype descriptions, avoid use of specific category name (ex. Sub-central) and just use general description in Abstract. Don't think that category name adds info for non-Irish readers or those unfamiliar with NPWS classifications.

5. line 105: unidentified acronym occurance? NECB.

6. lines 120-125. Objectives state two main research sites: 1960 cutover and 2009 cutover, but in Abstract and rest you discuss 5 sampling sites of different "eco-types".

So please adjust the wording to link your Objectives to the rest of your ms.

7. lines 142-145: Again there seems to be a mismatch in site description - here you say two sites were uncut and three cut, but in objectives on lines 120-122 it seems to suggest both sites were cut, just one left to recover since 1960 and the other site only since 2009. So please clarify your site descriptions. May be clarify that you have two main research sites and 5 sub-sites within them and how they all differ with respect to their management history. Also add reference to table 1 early in this paragraph.

8. lines 164 - you had trees on your sites? please include % cover in Table one or description. How large are they on average and species type, stem density.

9. LIne 167: collars were installed to represent ecolocigal variability - such as what?

10. lines 211: which light levels, not clear? Please list PPDF under which measured. Where measurements corrected for PAR reduction due to chamber transmittance reduction?

11. NEE modelling, section 2.5: modelled NEE to account for diurnal variability - based on what? did you measure diurnal variability in data? Line 243: PPFD used from which chamber? or outside? lines 245 and Table S3: when reporting stats it is insufficient to just present R2 values. Show also n-values and estimated coefficients. Also describe how many data points were used to fit the model and how many to test/validate the model fit? Did you do that?

12. Methane modelling: be very cautious in your "modelling" attempts and interpretations - you fit an empirical model to a small subset of observations and then attempt to use that to predict fluxes outside of the data range used to develop your empirical model. I don't think this is statistically sound, although I appreciate your attempt and sympathize with instrument malfunction. So highlight this limitation in your text and discussion. Line 265 - "collar average" probably should read "overall average from measurements at all collars".

13. Section 2.7, lines 278: - is that a valid assumption?

14. Lines 307-312: you discuss CO_2 evasion from drainage ditches, what about open-pond water on your bogs? Any present? what proportion? how much would the open ponds add to CO_2 efflux from open water?

15. Line 315: likely mean "DIC" instead of "DOC"?

16. LInes 321-322: Sentence makes no sense? what are you saying? "... from the sum of model error and error of input field variables"?

17. Lines 338: report st.dev on mean annual total from Ballyroan.

18. lines 340: 1978-2007 average taken from where? also report stdev on mean annual value.

19. Figure 4: hard to tell two blue colours apart, likewise for yellow and orange. suggest to change.

20. Figure 4 -7 - either show all modelled and observed fluxes like you do for CH4-fluxes in Figure 5a (I WOULD HIGHLY RECOMMEND, OTHERWISE YOU SHOW TOO MUCH MODELLED RESULTS but little observed values used to derive the modelled values!) or as monthly bar plots or cumulative plots like you do for terrestrial CO2-fluxes in Fig 4. This is also probably where you can reduce your figure numbers. Fig 5b probably belongs to Supplement where you describe your model fitting.

21. Section 2.4 name - CO2-gas flux measurement, not GHG.

22. Aquatic carbon losses: Fig 7: how do you know point around 2 mg/L is an outlier for DIC to assume a constant flux throughout the year? Seems too few points to make such assumption.

23. Fig 8: what's WHB and EHB?

24. Section 3.4: not sufficient to report only p-values for statistical results, report also

associated n used, mean and st.dev. Lines 404-406: was spatial variability accounted for in your analysis?

25. Figure 9a: - units unclear gC-CO2? CO2-equivalent? so Fig a and b are the same, with a in g/m2/yr and b in tones/ha/yr? why include both?

26. line 416: "carbon flux" probably mean "CO2 flux", same comment on lines 424. lines 416-417: unclear - so you looked at environmental controls for each collar separately? why not together per eco-type?

27. Section 3.5 - again stats should show n, mean, stdev together with p-value, else meaningless.

28. lines 428-433: don't get this paragraph.

29. Fig. 10: What if you colour points by ecotype? would be nice to see how they fit on the scatter, if group or not. in plots a and d - units are in gC, so does this C include CH4-carbon? Legend says data was averaged over 2 years - why? was there no interannual variability?

30. Discussion: Lines 436-437: well, I would be cautious with such as statement, as nowhere in your paper do you present simultaneous measurements of all components of c-balance you meausured. If you do have observation days where you have all of the fluxes measured on the same day - those would be your key days to focus on and show when trying to figure-out contribution of each component flux to overall C-flux. Such comparison, even if only on few days would be more valuable than that gapfilled modelled comparisons to field-based research.

31. lines 449-452: so did Nilsson et al also take a single measurement in a year and assume DIC to be constant? If not, how many they took and how the differences in sampling between their study and yours impacts the results. Think of n-sampled.

32. LInes 458: lower than Dinsmore and Nilson by how much? make it easy on the reader, so less likely to flip back and forth. show both values or state % difference.

33. SECTION 4.2 - I THINK THIS BELONGS TO RESULTS - this section should be split with synthesis plots shown in results and their discussion left in Discussion. ALso how data was collected and filtered should be in methods.

34. lines 532: how dry is "too dry"? also Briones et al reference is missing.

35. Fig. 11 - add lines to legend

36. lines 568-574 discussion - so how many points were from EC-derived NEE and how many from chamber derived-NEE? how do they fit on your Fig 11/12. Is there a difference between the two? (ex. one method consistently lower, but trends same, or one falls on one end of trend and the other at the other end?

37. line 577: "inter" probably should read "winter"

38. Fig 12: you specify your data points with numbers 1-5. I assume that relates to your ecotypes - so which is which? add to fig description.

39. Lines 606: "managing water table" - that's repeat of point 1).

40. line 608: "... the impact of these things must be considered." which things? and their impact on what?

41. Lines 621-624, follow discussion about impact of Sphagnum presence on GWP. So what has the study of Junkurst and Fielder to do with Spagphum-GWP?

42: Lines 628-635 - unclear what you're trying to say. Are you attempting to say that peatlands lifespan is more than 100 years, so their assessment should be based on longer time scales? So how long?

43. Lines 649: what's Marginal and Facebank ecotype? references?

SUPPLEMENT:

S1. GPPmax is assumed constant throughout what? which metrics from Wilson et al 2007 where used? how many data points were used for model development at each

point? why biological zero is assumed at 0C? what reference you have for this? Label your equations consequitively and consistently. SHow your model comparisons, how good each fit is. Why model fit to all collars - so did you check they all behave the same? where are the results?

S2. Equation S10 - which one is that?

S3. Tables S1 and S2 - kind of useless statistically. Please add estimated parameter coefficient's stats - p and t-values, also model stats such as R2, n-observations.

S3. Table S3: p-values? n? F-stats? data ranges used to fit model? all needed to make sense of reported R2.

S4. methane modelling - what worries me most. you fit an empirical model to limited data range and then use that to extrapolate beyond that data range. Don't think that's good statistical practice. Be cautious of such things. If there's a physiologically based model to work with - try that instead. Was effect of Temp similar to that of ER - show? "Temporal variation in fluxes was extrapolated in this model" - what are you trying to say?

Also was there any model validation done for any of your modelling activities?

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