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Open Access Earth System Science Data Discussions



# *Interactive comment on* "A new dataset of soil Carbon and Nitrogen stocks and profiles from an instrumented Greenlandic fen designed to evaluate land-surface models" *by* Xavier Morel et al.

**Xavier Morel et al.**

morelxavier1@gmail.com

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Thank you very much for your review and your constructive comments on this manuscript. I hope that the explanation given below, and the changes to the manuscript, will provide an adequate response. Referee comments are indicated as "RC" and author responses as "AR".

RC : This is an interesting and overall well written manuscript about the C reservoir in the Nuuk peat area, Greenland.



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AR : Thank your for your comment.

RC : The manuscript is overall well written manuscript about the C reservoir in the Nuuk peat area, Greenland. There are some linguistic problems that need to be corrected, as already noted by the other reviewers, so I will not go into detail here.

AR : We will have the manuscript corrected by a professional english speaker

RC : The most critical point of this paper relates to the very limited database. Only two transects have been sampled (n=135), only on one particular fan, which is actually quite small (as far as I can see, the sample area is only half a hectare, and the total size Âń 0.1 km2 ??), and no attempt has been made to extrapolate these data for the whole peatland.

AR : The small number of samples (n=135) is explained by two reasons. The first one is due to the aim of the paper, which is to sample soil carbon data in close vicinity of greenhouse gas chambers in order to have data from both the state variables (i.e. soil carbon stocks) and the greenhouse gas fluxes. Hence the focus on this zone of the fen. The second one is purely logistic, as we did not have the time to conduct additional surveys.

However, we agree with the reviewer that it could have been interesting to extrapolate the mean soil carbon density value over the whole fen area. But doing so properly means to have informations of the Organic-Mineral Interface (OMI) depth over at least the two major axes of the transect to construct a 3D-model of the fen basin, as OMI depth will mainly determine the vertically integrated soil organic matter content. With our data, the best estimate we can propose for soil carbon content over the whole fen area is a very basic one, i.e multiplying the mean soil carbon mass per unit surface (35.5 kg.m-2) by a rough estimate of the fen area (approx. 7500 m2, see enclosed image). This gives a total carbon content for the fen of 266 250 kgC. This estimate has been added to the manuscript.





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RC : The authors say that the whole study area is 32km2, but is this all peatland? The satellite image does not look like that but rather point to the small studied hotspot only.

AC : The studied fen is a small part of a greater study area of 32 km2, studied within the program Greenland Ecosystem Monitoring (https://g-e-m.dk), a long-term research programme on ecosystems and climate change effects and feedbacks in the Arctic. The focus of this paper is the fen soil carbon stocks, as the fen is already instrumented to collect greenhouse gas fluxes. We rewrote section 2 to avoid confusion.

RC : The editors will have to decide whether this is sufficient for ESSD, but in any case the authors should give a more detailed justification for the uniqueness of this peatland and the associated data, and how they think we may improve the global C estimates by adding data only from this particular site.

AR : The primary aim of this new dataset is not necessarily to help improving global C estimates as indeed the size of the fen is quite small, but to help testing and improving process-based biogeochemical models that model both soil carbon profiles and corresponding greenhouse gas fluxes (e.g. Morel et al, 2019). Therefore there is a need for soil carbon measurements co-located with greenhouse gas measurements. With our measurements, Nuuk fen becomes one of the rare fen sites where soil C and CO2 and CH4 fluxes are measured.

RC : Another critical point concerns gas flow measurements. I agree with the authors that there is little documentation on the combined gas flow and C-stock analyses in such fens. However, the authors do not present these gas flow measurements. To show them in combinations would have been a more valuable contribution to ESSD.

AR : We chose to not show the gas flow measurements in this paper, as they have been already published and used in previous works (e.g. Pirk et al., 2017 ; Morel et al, 2019). However, we add in the text a description of these fluxes : "Nuuk CO2 and CH4 automatic chamber fluxes measurements starts in 2007 and are still ongoing. For each year, the methane (CH4) flux pattern reflected a dome-shaped peak with





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a maximum in July/August, and a decline to about half of the maximum towards the end of the summer season, usually in early September. In the autumn the methane flux continued to decline and it decreased consistently during September and October. The peak summer emissions reached about 6 mg CH4 m-2 h-1. For CO2 fluxes, mean fluxes at the peak of the growing season (ie when photosynthesis is a much larger flux than soil respiration ) are in July/August and are approximately -300 mg CO2 m-2 h-1.

RC : Unfortunately, this well-sold aim of the introductory part is not taken up again in the present form. More information about the landscape is needed (morphological peat soil descriptions, underlying geology of the parent material, pH values of the surrounding area (if available) and information concerning the history of the peatland.

AR : We add in the manuscript the underlying geology of the parent material, which is bedrock composed of Archaean tonalitic to granodioritic gneiss, and Qorqût granite. As for the history of Peatland, we state that it is not older than 8500 BP (Larsen et al., 2017).

RC : Why? Why do we need to consider such small peatlands in our global C-flow assessments?

AR : The primary aim of this new dataset is not necessarily to assess global C-flow assessments with global carbon cycle model or to refine global soil carbon stocks as indeed the size of the fen is quite small, but to help testing and improving process-based biogeochemical models that model both soil carbon profiles and corresponding greenhouse gas fluxes (e.g. Morel et al, 2019). These process based biogeochemical models, once tested on data like this, are coupled to Earth System Models, the models that are used to simulate future climate.

RC : Minor Comments :

RC : The small size and depth of the peatlands should be mentioned in the summary.

AR : done





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RC : The introduction should also mention N The diameter of the corer is quite small (4 cm).

AR : done

RC : Can you provide references that quantify the errors of the corresponding bulk density evaluations, and could you add these uncertainty ranges to your data in a way?

AR : I am not sure what bulk density uncertainties you are referring to.

The measured bulk densities (BD) are computed as BD = (1-Fwet) * SD with Fwet the water massic fraction and SD the sample densities. Fwet and SD have been directly measured, and uncertainties on bulk densities are directly related on SD measurements, addressed in the next comment.

RC : I appreciate the criticism (page 5/6) that has been expressed regarding the bulk density measurements. But how have these problems been solved, if you just list them, it doesn't help.

AR : Thank you for your comment. The first two issues listed (potential soil compaction and soil water loss by using the manual gouge auger) are inherent to the method used, and are limited by being extremely careful during the sample extraction operation. The last one, concerning difficulties of sample volume measurement for water-saturated sample, has been partially adressed by using known volumes vials in the laboratory for these almost liquid samples. More solid samples volumes has been measured with a vernier of 0.1 mm precision.. We added this precision in the manuscript.

RC : Tables 3-4 could be combined, they should also show bulk density and C/N values, and they should contain geo-referenced coordinates

AR : done. Also, geo-referenced coordinates for each sub-plot (T1-0, T1-5, etc) are mentioned in the corresponding dataset (https://doi.pangaea.de/10.1594/PANGAEA.909900). We also add geo-coordinates





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informations on Figure 1, as other reviewers asked.

RC : Overall, I like this work and the way it is presented, but I wonder how representative is such a small area for peatland C fluxes in the world. If accepted, certainly more effort should be made to convince the reader that such a small peatland is unique enough to be included in ESSD rather than as a data paper in a more disciplinary journal.

AR : As mentionned earlier, the dataset is mostly important because of the coherent measurements of fluxes and stock, that are rare for peatlands. The introduction is being rewritten to stress this more clearly, and we emphasize more in the text the need for belowground carbon measurements co-located with carbon flux measurements in order to test and improve process-based biogeochemical models.

References :

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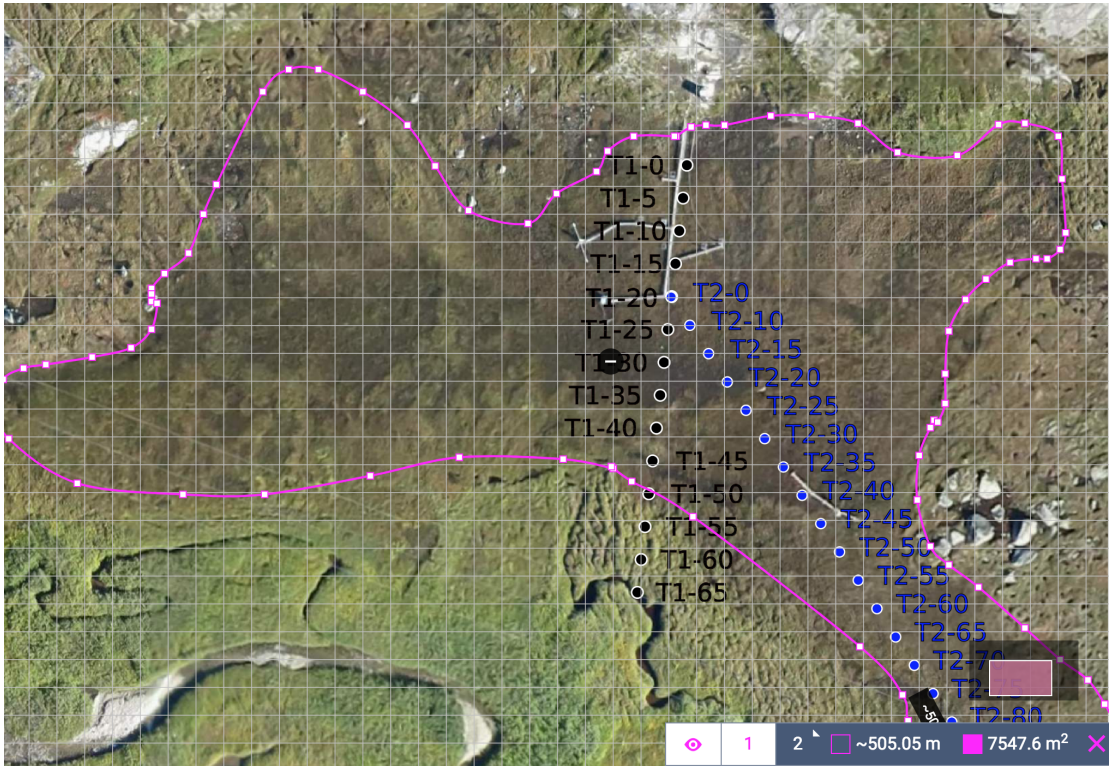


**Fig. 1.**



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