

## ***Interactive comment on “The limits to northern peatland carbon stocks” by Georgii A. Alexandrov et al.***

### **Anonymous Referee #1**

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Alexandrov et al. raise an interesting topic and modeled the potential for carbon sequestration in northern peatlands. They show that large amounts of carbon in the atmosphere could be offset by peatland growth throughout the current interglacial. I think the study focuses on an important topic and the results are worth publishing, however, the methods and the results need to be presented in a revised, more precise and coherent form. I think the paper should be significantly revised before consideration of publication. Please see my detailed comments below.

#### Abstract:

Please insert one or two statements about the methods, which you applied in this study. Also, include a statement about your results, where you specifically mention the amount of carbon which could be set off by peatland growth.

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In addition, I would recommend changing the title of the manuscript into “The potential of northern peatlands for carbon sequestration”

#### Specific comments:

Page 1, Line 10: Maybe write “continuous” instead of “persistent”

P1, L.12: Rewrite the sentence. E.g. “The evaluation of the carbon sequestration potential of northern peatlands show that atmospheric carbon dioxide concentration can be significantly reduced. Northern peatlands have the potential to be the second largest CO<sub>2</sub> sink after the world’s oceans.”

#### Introduction:

##### General comments:

The introduction needs a better structure. The different paragraphs need to be connected better and the research gap should be mentioned more clearly. Also, state in the end of the introduction what the goals of your study are. The last two paragraphs (p2, line 17-29) belong into the methods part and should be removed from the introduction.

##### Specific comments:

Page 1, Line 17: You mention the study by Loisel et al. (2014). Please also include the new study by Treat et al. (2019) in your introduction

P1, L.17 : I suggest to use the word “knowledge” instead of “wisdom”

P1, L.21 : I suggest to use the word “previous” instead of “later”

P1, L.23 : Where do northern peatlands start? Is it >40° North or >45° North, please clarify

P1, L.25: 864-2240 PgC – Is that already your result or is it from a different study – please clarify

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P2, L.13: I suggest to use the word “rise” instead of “elevation”

Methods:

General comments:

The methods are somewhat unclear to me. You start with an explanation of the maximum depth of peat, however in equation 1 you show how the maximum C stock can be calculated. You could start with an equation for the maximum depth of peat before introducing the maximum carbon stock in a grid cell. In addition, I suggest to make subchapters to explain the different model parameters. The first subchapter could include the maximum carbon stock in a grid cell, whereas a second subchapter includes the extrapolation from the grid cell to the entire northern peatland area and a third subchapter explains the differences between a conservative and non-conservative interpretation of  $f_p$ . Also, in the end of the methods, it appears to be a mix of discussing your methods and presenting some results already. I suggest you discuss your methods in the discussion section with a separate subchapter and strictly separate between methods and results, so that no results appear in the methods section.

Specific comments:

P3, L.3: What is the density of draining system – please explain

P3, L.4: What is the impeded drainage model? – If this is your own model, you should explain it in the methods, otherwise add a reference.

P3, L.6: I do not understand the second, smaller equation. Why is  $h_{max}$ , the maximum height of the water table above the level of the draining system, dependent from the fraction of the area occupied by peatlands?

P3, L.9: Change the sentence to “. . .  $h_{max}$  is the maximum height of the water table above the level of the draining system. . .”

P3, L.26: How much is the minimal depth of the peat layer which is used to classify a

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land unit as peatland? – Please give a number or a range for the minimal peat depth.

P4, L.1-11: This part would better fit into the discussion where you could have a subchapter discussing your methods and your model.

P4, L.12: What is the non-conservative and what is the conservative interpretation of  $f_{p,obs}$ , please add values

P4, L.13: 1258 vs 665 PgC. This is a result and should therefore be in the results chapter

P4, L.14: Please replace “one cannot expect. . .” with “it cannot be expected. . .”

P4, L.18: Please replace “one may assume. . .” with “it can be assumed. . .”

P4, L.21: “peat C addition” do you mean C accumulation?

P4, L.23: 875 PgC. This is another result and should therefore be in the result section.

Results

General comments:

Please present here your own results and do not start with a comparison to another study. Instead of all the numbers from Gorham (1991), present your own results for mean depth of peatlands, mean bulk density or area of peatlands. The comparison with Gorham (1991) as well as Yu (2011) belongs to the discussion part. The results section needs to be rewritten completely with a focus on your own results.

Specific comments:

P5, L.5: Add the year of publication after Yu

P5, L.10: Add the year of publication after Yu

P5, L.10: Please change “one could find” into “it is reasonable to agree. . .”

P5, L.11: Why 875 PgC? What is with the 665 PgC – 1258 PgC? What is your main

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result? This needs to be clear.

Discussion:

General comments:

The discussion is very short. Please provide a more in-depth discussions of your methodological approach, e.g. show the benefits but also limitations of your model and compare your results of potential C accumulation with e.g. C accumulation during the Holocene. I suggest making several subchapters. One where you discuss the benefits and limitations of your model, including the uncertainty of your estimation. Another subchapter where you compare your results with previous studies (as you did in the results section) and a third subchapter where you discuss the implications of your results on the global C cycle (basically your actual discussion).

Specific comments:

P5, L.14: Change the first sentence into: "The potential for northern peatlands to store carbon were estimated for the first time..."

P5, L.15f: Change the following sentence into: "We adapted this methodology to global scale and additionally included geomorphological aspects of peat bog growth..."

P5, L.18 : Write "Our estimate..." instead of "Moreover, this..."

P5, L.18: Delete "somewhat"

P5, L.19: Change the following sentence into: "This assumption, however, might not be relevant for scenarios of dramatic changes in the Earth system that will take place if cumulative carbon..."

P5, L.20-21: Why 1000 PgC? It seems a bit arbitrary to me? Can you discuss this a bit more?

P5, L.21f: Change the following sentence into: "Nevertheless, if cumulative carbon

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emissions do not exceed 1000 PgC, the northern peatlands play an important role in global carbon cycle recovery"

P5, L.21: What happens to the peat C storage if carbon emissions exceed 1000 PgC?

P5, L.26 : Replace "plain" with "other"

P6, L.1-4: You should also discuss the conditions and timeframe under which such a scenario can happen. Is this only under ideal conditions? What about the limitations in the model? Also, if you make such a strong statement, there should be a better explanation of this Earth system model of intermediate complexity.

P6, L.2: Maybe you can elaborate a bit more on figure 4. How does the orbital forcing affect peatland C uptake?

P6, L.2: "in relevant time frame" – Can you give a number, what a relevant time frame is?

P6, L.3 replace "won't" with "will not be able to"

Conclusions:

P6, L.7: What are limits to peatland growth? – Please discuss this in the discussion section

P6, L.10-16: This section is somewhat contradictorily in itself and compared to other parts of the manuscript. Why is the cumulative carbon removal associated with the natural development of peatland ecosystems limited? – Please discuss this in the discussion section

Supplement

Please add a reference list for the supplement

S1.1 : Please rephrase the first sentence.

References:

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Gorham, E.: Northern peatlands: role in the carbon cycle and probable responses to climatic warming, *Ecol. Appl.*, 1(2), 182–195, doi:10.2307/1941811, 1991

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Yu, Z.: Holocene carbon flux histories of the world's peatlands: Global carbon-cycle implications, *The Holocene*, 21(5), 761–774, doi:10.1177/0959683610386982, 2011.

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