

General Comments:

I feel that a potential reader will benefit from inclusion of a study area (region) map to give context to the scale and geographical context of the region of interest. I particularly enjoyed seeing the maps in the Supplementary Information file and a map depicting this area will greatly benefit this manuscript.

Author's response: We've moved SI Figure2 to the main text. SI Figure2 shows the extent of wetlands in 1940-1990, which is the initial wetland extent for future simulation.

I find that the text relating to your workflow methodology is confusing, this will be greatly improved if the authors include a simplified figure of the steps taken in the analysis. In the current format, the workflow methodology is difficult to follow and potentially replicate and test in future studies.

Author's response: We've divided the workflow into two parts and simplified each part. To help understanding, we also added a SI Figure 1 to explain the way we estimate wetland extent dynamics.

Some parts of the manuscript lack clarity and careful attention needs to be given to this.

The use of multiple abbreviations makes the manuscript difficult to read in places where multiple abbreviations are used concurrently.

Author's response: We deleted the abbreviations for the uncommonly used terms in the paper (e.g., CRU, ALD, FAO), and added Table1 at the beginning of the Method section for abbreviations and their full names.

Please provide context to the reader when referring to "run-on".

Author's response: It refers to the water input from nearby water body or ground water to the peatlands. We've added this explanation to where run-on shows up the first time (Introduction, line 61).

Specific Comments:

Line 7: This sentence lacks clarity, have they been a C sink during the entire Holocene?

Author's response: The text was changed to 'have been a large C sink'.

Line 14: Adjust the text to "C sources are attributed to 1) peatland water table depth..."

Author's response: The text was changed as suggested.

Line 19: It will be beneficial to the reader to indicate specifically how much earlier this shift will take place.

Author's response: We've specified 'This study predicts an northern peatland sink to source shift in around 2050, earlier than previous estimates of after 2100 in the literature...'.
'

Line 22: Please provide an in-text reference for the primary reference of this definition of peatland ecosystems.

Author's response: The reference was added.

Line 29: Please provide details on the phenology of peatlands in this region.

Author's response: We've added a reference on phenology and specified 'triggering spring onset earlier and delaying autumn green-down'.

Line 29: The authors use the word "severe", rather quantify (increase in °C) being currently measured or projected between the Arctic region and surroundings. This needs more detail.

Author's response: We've added details by saying 'the warming in the Arctic region is almost three times as much as the global average'.

Lines 28-35: It is unclear whether these changes have been observed already (and have been quantified) or they are projected climate warming influences. As the previous comment suggests, please be more specific here. This detail will add to your argument.

Author's response: We've added details (bolded words):

Peatlands are vulnerable to disturbances induced by climate warming (Loisel et al., 2021), especially when the warming in the Arctic region **is almost three times as much as the global average** (GISTEMP-Team., 2021). First, warming influences northern terrestrial ecosystem vegetation productivity by increasing spring photosynthesis, **triggering spring onset earlier and delaying autumn green-down** (Piao et al., 2008; Helbig et al., 2017, Richardson 2018). Second, warming could induce drier Arctic conditions **with 21% of lake count and 2% of lake area decrease found during 1960s-present** (Finger Higgens et al., 2019), and peatlands water table drawdown would result in **net increase of greenhouse gas emissions of 0.86 Gt CO₂-eq ·yr⁻¹ by 2100** (Huang et al., 2021). Third, decomposition rate increases under higher temperature and previous studies found positive linear correlations between warming and **net C loss rate of 31.3 gC·m⁻²·year⁻¹·°C⁻¹** (Hanson et al., 2020). Fourth, permafrost thaw under warming conditions will expose previously-frozen C for **dissolving and decomposition** (Gandois et al., 2019)

Line 88: What about the peatland dynamics? This sentence must be rephrased as it is misleading.

Author's response: We've rephrased the sentence to 'Although this study aims at the peatland C expansion, shrinkage, accumulation and decomposition after 1990...'

Figure 1: Within the figure boxes please include the reference (citation) of the different datasets used. This will also aid in describing your workflow.

Author's response: We've added the citation to the workflow.

Line 414: Adjust the text from "no" to not

Author's response: 'no' was replaced by 'not'.

Line 436: Adjust the text from "depending" to depends.

Author's response: 'depending' was replaced by 'depends'.