EGUsphere, referee comment RC3
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Comment on egusphere-2022-1006

Anonymous Referee #3

Referee comment on "Peatlands and their carbon dynamics in northern high latitudes from 1990 to 2300: a process-based biogeochemistry model analysis" by Bailu Zhao and Qianlai Zhuang, EGUsphere, https://doi.org/10.5194/egusphere-2022-1006-RC3, 2022

Zhao and Zhuang simulated the response of northern peatlands to climate change until 2300 using PTEM, and predicted that northern peatlands will change from a C sink to a C source under all scenarios (RCP2.6, RCP4.5, RCP8.5). The only exception is the climate of bcc-csm1-1 under RCP2.6 scenario, with which northern peatlands will remain a C sink. Overall, I recommend publication of the manuscript, pending that the comments below are addressed.

General Comment:

If I understand it correctly, the authors first use TOPMODEL to simulate wetland extent, then wetland areas with peat thickness>=30 cm are defined as peatland. However, the distinction of wetlands and peatlands in the paper are fuzzy. For example, in SI Figure2, it compares wetland abundance with peatland maps, an evaluation of simulated wetland area is missing. The paper sometimes confuses wetlands and peatlands in the main text.

Is peatland resilience considered in the model? Lowering of water table and enhanced decomposition can lead to compaction of surface peat, with a lower hydraulic conductivity, it helps maintain soil moisture and slow down decomposition.

It is hard to read the manuscript due to too many abbreviations, and too many procedures to make the start of new simulations consistent with the Holocene simulation.

Specific Comments:

L53-54: peatland extent in Qiu et al., 2020, Müller and Joos, 2021 are not fixed. Both studies dynamically simulated peatland area in the future.

L62-63: Incomplete sentence, when peat thickness is ?

Eq.9: Why moss has been excluded from the calculation of evapotranspiration? Is it because the FAO algorithm and Penman-Monteith model are not applicable to moss? Anyway, moss shouldn't be neglected not only because of their high abundance in peatland, but also because of the special characteristics of moss: due to the lack of stomata, moss cannot control the water loss to the atmosphere.

L254-255: If the 50-year running mean WTD for a bin is shallower than 25cm for only one time during the whole 1990-2300 timeseries, then this bin is "potential peatlands"? Would be informative if you could add a figure to show the frequency distribution of long-term WTD of all bins/grid cells.

L302: higher than what? Should be "increasing temperature and precipitation"?

L310: stable throughout 1990-2300? the increase in temperature obviously slows down after 2200

SI Figure9: Even at present-day, 1990-2000, pan-Arctic peatlands are dominated by woody PFTs? Is it realistic? A validation of simulated vegetation composition is missing in this manuscript.

L358: In Figure4 3(a), CO2 emission (net ecosystem exchange, NEE?) are positive over 1990-2300 for both bcc-csm1-1 and IPSL-CM5A-LR, that means pan-Arctic peatlands are C sources during 1990-2100 under bcc-csm1-1 RCP 2.6, isn't it?

L446-447: I couldn't find Table 2 in the manuscript.

L487-488: Isn't WTD a more direct driver for peatland area change? Why high decomposition rate result in peatland area shrinks?