**Reviewer Comments and Author Responses**

The authors would like to thank the reviewer for the comments and suggestions. The reviewer comments are provided below in black and our response in green.

1. Does peat decomposition take temperature and recalcitrance effect into account? I didn't see this part described in the article

We do not include the influence of temperature and recalcitrance in the decomposition model because they will increase the number of empirical parameters and assumptions, which might lead to a higher uncertainty of the model. The effect of temperature on the decomposition process could be employed through $Q_{10}$ parameter (Morris et al., 2015). However, this parameter has a high range of values between 1 and 10, which depends on the peatland types and temperature characteristics (Hardie et al., 2011; Xiang & Freeman, 2009). Moreover, the inclusion of the recalcitrance effect requires additional assumptions related to the changes in the rate of decay that could decline linearly or quadratically, as shown by Clymo et al. (1998). Therefore, to reduce the model uncertainty, we use a fundamental decomposition model based on Clymo (1984) without temperature and recalcitrance effect. We added a few lines to clarify this issue.

2. Taking into account the weight of the plant is an innovation. The manuscript sets the plant weight to the surface portion, which may be applicable to *Sphagnum*. In the case of sedges or shrubs, the underground root system is also part of their productivity, and in some sedges the underground productivity is even greater than the above-ground part. How do you define plant weight for this type of vegetation with a rich root system? The roots of these plants can be up to 1 metre long and penetrate the peat layer

The plant weight from vegetation with a root system could be modelled through the data of above-ground and below-ground biomass. Furthermore, the plant weight is applied not only at the top surface but also at the specific depth of the peatland, depending on the root characteristics. However, implementing this process in MPeat2D might increase the complexity and reduce the generality of our model because the depth of maximum biomass production from the root, which influences the total weight, is controlled by the peatland types (Moore et al., 2002). The influence of the root system might become crucial for the future development of MPeat2D for modelling tropical peatland behaviour because it affects the mechanical stability of the peatland. We added a few lines to emphasize the importance of the root system and how to implement it on MPeat2D for future development.

3. Line 28: It would be useful to explicit to state what is being highlighted, so the sentence would be more informative. Or reword to “we argue that …feedbacks are important for spatial hetereo….”

We agree to state the important findings of the paper explicitly and rephrase a few lines in the abstract.

4. L47-49: The meta-analysis by Morris et al. (2022) on the variation of dry bulk density and hydraulic conductivity with peat depth (including the relationship between dry bulk density and hydraulic conductivity) would support your point.

The suggestion had been implemented in the manuscript.

5. L175-179: Ecological submodel (2.2). The peat production model in this study is based on the formation of Morris et al. (2015), which was for Sphagnum-dominated peatlands (Belyea and Clymo, 2001). However, in the PFT section you have set Sphagnum, sedge and shrub depending on the water table depth, I'm not sure that the peat production model used here is suitable for calculating sedge and shrub production.Need to explain this clearly. The formula of Swinnen et al. (2021), which has no restriction on plant type, could be an option.

The authors agree that the peat production model used in this manuscript has its disadvantages. However, this peat production model can couple the ecological and hydrological processes through the dependency between peat production and water table depth. Furthermore, it also includes the effect of air temperature, which leads to a more realistic model. Swinnen et al. (2021) employ the global Thornthwaite Memorial equation (Lieth, 1975) that models the primary productivity of the world. This model might omit the unique characteristics and the important feedback from the peatland ecosystem. We added a few lines to clarify this issue.

6. L298. Figure 4 and other relevant figures. As the simulation results were from sensitivity simulations and the results are not really comparing with down-core observations, it is probably better to use “Simulation time (years)” as time unit, rather than “Age (years BP)” throughput the manuscript. Indeed, in the text and some figures (like Figure 5) the time is often referred to as “years”.

The suggestion had been implemented in the manuscript.

7. L300: change “between 0.6-1 m yr-1” to “between 0.6 and 1 m yr-1” and elsewhere to use “between … and …” phrase structure.

The suggestion had been implemented in the manuscript.

8. L320: The MPeat2D model output of water table depth under constant climate conditions continues to decrease after the initial period of peat accumulation (380 years), indicating that the peatland is becoming wetter (Fig. 6). This would provide some cautions to the study of palaeoclimate change using peat as an archive, as peatlands are generally thought to maintain a stable hydrological environment for long periods of time without climate change and disturbance. The model does not seem to be able to discriminate clearly whether changes in water table depth are due to climate change or to the model itself (autogenic process).

The decreasing water table depth under constant climate (Figure 6) occurs due to an autogenic process. The loading from peat accumulation increases as the peatland grows, which provides internal feedback mechanisms on the water balance through the deformation of peat pore space. The smaller pore space results in the reduction of active porosity and hydraulic conductivity, which supports the water accumulation. We added a few lines to explain the decreasing water table depth under constant climate on the MPeat2D.

9. L429-430. In the vertical direction, a comparison of the model output peat bulk density with field measurements (layer-by-layer comparisons) could demonstrate the superiority of the MPeat2D model, rather than just a comparison between values. However, such data may not be available.

We agree that layer-by-layer comparison in the vertical directions of bulk density could indicate the superiority of MPeat2D for modeling the changes in peat physical properties. However, this comparison method requires specific information and input data, including Young’s modulus, PFT composition, climate conditions, and topography from the observed area. Moreover, it might increase the number of free parameters from the model to capture the particular characteristics of the peatland site. The aim of this paper is to provide a general model of peatland development that incorporates mechanical, ecological, and hydrological processes in two dimensions and consider the potential implications of feedback within this model system. Therefore, we employ the comparison between values obtained from the typical range of peat physical properties from the previous studies.

10. L451-454: The MPeat2D model outputs water table depths that are dramatically expanded during the early stages of peat accumulation (hundreds of years). Hydraulic conductivity is variable in both MPeat2D and DigiBog, and its highest in the early stages of peat formation, what causes the initial water table depth in MPeat2D to be different from that in DigiBog (Fig.11)? Is there a difference in initial hydraulic conductivity?

The sharp expansion of the water table depth is due to the fact that the water table does not rise with peat accumulation; was the peat layer free of water during that period? Can vegetation still grow and accumulate peat in the early peat layer without water?

The variation in water table depth between MPeat2D and DigiBog during the early stages of peatland development occurs due to the difference in the bulk density assumption. MPeat2D allows bulk density to evolve during the development process, while DigiBog assumes bulk density constant over time. The changes in bulk density with time in MPeat2D occur because of the mechanical compaction on the peat pore space. Consequently, in the early stage of development, the value of bulk density from MPeat2D is lower than DigiBog, producing a more rapid increase in peat thickness and a faster appearance of the unsaturated zone. The vegetation can still grow and accumulate peat because the maximum water table depth from MPeat2D, with the value of about 0.3 m, is in the range of water table depth that supports the growth of peatland vegetation (Moore et al., 2002). We added a few sentences to explain the difference in the water table depth profile between MPeat2D and Digibog, particularly at the early stage of peatland development.

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