Mahdiyasa et al. developed a two-dimensional peatland process model that incorporates essential mechanical-ecohydrological feedbacks, which can simulate the spatial variability of an individual peatland, especially the differences in physical properties between the peatland centre and edge. The main difference from previous models is that the model considers mechanical deformation and simulates variable peat porosity and dry bulk density. Sensitivity simulations of MPeat2D successfully produce different vegetation compositions between the margin and the centre and show a higher bulk density and lower hydraulic conductivity at the peatland margin compared to the centre. The methodology on plant weight is interesting and the methods section is generally well described. Overall, I enjoyed reading this manuscript, which generates some new ideas about the development of peatland models. I recommend the acceptance of the manuscript after considering the following suggestions/comments.

Major comments:

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

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.

Specific comments:

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….”

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.

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.

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”.

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.

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).

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.

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?