Dear Prof. Stocker,

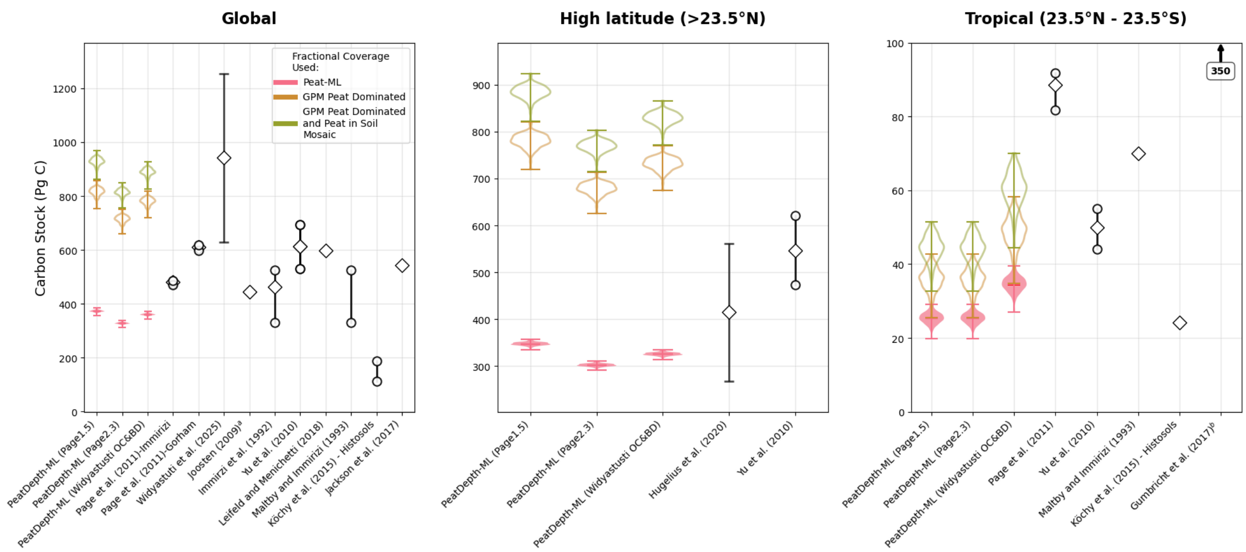
Thank you for handling our manuscript and your comments. We would like to respond to a few points that you made in your editor report (your comments in blue font):

The suggestion about showing peat depths only for areas with substantial peatland reflects a point that I think could be better explained: If I understand this correctly, the depth map is to be taken as an independent factor in the multiplication with peatland fractional coverage (l. 235). This seems fundamental for contextualising your results and understanding your choice for displaying results (Fig. 5). This aspect, and in general the relation of your study to Melton et al. (2022) could be clarified early on and more extensively in the introduction.
I think point 2 of Reviewer 2 is related to this aspect. Given that the peat depth prediction is used as a factor in the multiplication with peatland fractional coverage (in other words: the model is by design prevented from predicting false positives if the peat depth is multiplied with peat fractional coverage), the choice for including a large fraction of non-peat data in the model training could be explored more extensively, ideally with a sensitivity analysis.

As a point of clarification - our peat depth map has *no* dependence on the map of Melton et al. (2022). We do use the basic machine learning model framework, but as discussed in Section 2.3 *Adjustments to Peat-ML Framework*, we adapt it to estimate peat depth, rather than peat extent.

PeatDepth-ML predicts peat depth only in peatlands in a grid cell (line 237) and is on a 5 arc minute grid (Figure 3). Since the grid resolution is moderately coarse, when estimating global peatland carbon stocks we need to apply a fractional peatland extent to determine how much of a grid cell is actually peatland. Once that fraction of a grid cell is determined to be peatland, we can take our modelled peat depth along with values of organic carbon and bulk density to estimate carbon stock in the peatlands. Treating every 5’ grid cell as totally peatland covered results in unreasonable peatland carbon stocks (around 3250 Pg C). If we take our results as shown in Figure 5 and apply a threshold (e.g. 30 cm), we still end up with an overestimate of global peatland C stocks (ca. 3140 Pg C) due to the points mentioned above.

To ensure our estimates are reasonable we use a fractional wetland extent map to limit our estimation to only the peatland parts of a grid cell. We originally did this using Peat-ML (Melton et al. 2022) as it is a published map, but have now expanded to include the unpublished, but available, Global Peat Map (Greifswald Mire Centre 2022) to further demonstrate here that any map of peatland fractional cover could be used. Below is a revised Figure 13 showing our original results with Peat-ML along with new ones using GPM:



Revised Caption: Carbon stock estimates for (a) global, (b) high latitudes, and (c) tropical peatlands provided using PeatDepth-ML predicted peat depths, two different peatland fractional extent maps, along with literature estimates. The PeatDepth-ML estimates use predicted peat depth measurements along with different assumed organic carbon contents and bulk density thereby allowing an estimate of the total peatland carbon stocks (see Section 2.5). The peatland fractional cover maps include Peat-ML (Melton et al. 2022), which we term our 'best' estimate' and two variants of the Global Peatland Map (Greifswald Mire Center, 2022): 'peat dominated' and 'peat dominated + peat in soil mosaic'. The estimate from Gumbricht et al. (2017) is over a larger region than the other tropical estimates (38°N - 56°S, 161°E - 117°W). The value for Joosten (2009) is from Minasny et al. (2019).

As you can see, the large peatland area estimate from the GPM causes our peatland C estimate to rise significantly. We originally did not include the GPM in Figure 13, as it is unpublished and little information is available about its provenance. Similarly, we also prefer to not use the PEATMAP product due to deficiencies in the product as discussed in Melton et al. (2022): *PEATMAP (Xu et al., 2018), which was generated through a meta-analysis of regional-scale mapping products of varying spatial resolution and provenance (general land cover maps, soil databases, and a hybrid expert system). This dataset is not well suited as a peatland mask for ESM use as the resolution of some of its parent datasets leaves large polygons of complete peatland cover in regions where this is unlikely and it misses peatlands in regions where peatland coverage is known to exist, e.g. the Republic of Sakha (Yakutia, Russia), as it is dependent upon mapping products existing for each region.*

However, given your comments and those of the reviewers, we understand the value in making it easier to see the influence of the peatland fractional extent map used. Additionally, we agree that it can be made more clear that the choice of a peatland extent map is arbitrary and has large impacts upon our estimated peatland soil C stock estimates.

We have replaced the opening sentence of Section 2.5 *Calculation of Global Peatland Carbon Stocks* from:

We used PeatDepth-ML results for basic C stock estimates, following an approach similar to Widyastuti et al. (2025) …{equations 1, 2 + definitions}... We calculated A_{cell} using Peat-ML's peatland fractional coverage by determining each grid cell's trapezoidal area and scaling by peat coverage fraction. This application of Peat-ML is necessary because PeatDepth-ML predicts mean peat depth only over the peatland area within each grid cell.

to:

PeatDepth-ML predicts mean peat depth only over the peatland area within each grid cell. To allow estimation of global peatland C stock, we require a peatland fractional extent map that will give the peatland fraction of each PeatDepth-ML grid cell. While any fractional peatland map can be used, we select Peat-ML as our 'best' estimate as it is on the same grid, provides fractional extent, and is a peer-reviewed product (Melton et al. 2022). To provide an alternative estimate we also use the Global Peatland Map (Greifswald Mire Centre 2022) although it is unpublished and little information is available about its provenance. To obtain a basic estimate of global peatland carbon stocks we follow an approach similar to Widyastuti et al. (2025) …{equations 1, 2 + definitions}... We calculated A_{cell} using Peat-ML's peatland fractional coverage by determining each grid cell's trapezoidal area and scaling by peat coverage fraction.

Later, in Section 3.4 *Estimation of Peatland Carbon Stocks Using PeatDepth-ML Results*, we added this sentence at the start of the section:

PeatDepth-ML requires a peatland fractional extent map to produce an estimate of peatland carbon stocks as the model estimates the mean peat depth only over the peatland area within each grid cell. We have chosen Peat-ML to provide peatland fractional extent as our 'best' estimate (see Section 2.5) but any other peatland fractional extent map could be used and we provide an estimate based upon the GPM as an alternative.

At the end of Section 3.4, we have changed the last sentence from:

A potential shallow bias in PeatDepth-ML may contribute to these lower carbon stock estimates.

to:

A potential shallow bias in PeatDepth-ML may contribute to these lower carbon stock estimates, however the larger influence is the selection of Peat-ML to derive our 'best' estimate, which has a smaller peatland area estimate than GPM as used by Widyastuti et *al. (2025) and results in an estimate of peatland C stocks less than half those derived via GPM (Figure 13). The strong influence of peatland fractional cover maps in the calculation of peatland carbon stocks reflects not only differences in total peatland extent (e.g. the large differences between Peat-ML and GPM as mentioned above) but also differing fractional extents in areas of shallow versus deep peat (even if total extents were the same) will have large impacts on total peatland C estimates.*

We then highlight how much uncertainty comes from the use a peatland fractional map in Section 3.5 *Model Limitations and Future Work* where we add the following to the end of the Section:

Lastly, our peatland carbon stock estimates are heavily influenced by the choice of the peatland fractional extent map as seen in Section 3.4. Future work could reduce the grid spatial resolution (e.g. 250 m) to make the use of a peatland fractional map unnecessary.

Our final modification is to the *Conclusion*. We change this:

Estimated global peatland carbon stocks were between 327 - 373 Pg C, which was within the range of previous estimates.

to:

Estimated global peatland carbon stocks were strongly dependent upon the peatland fractional cover map used. Our 'best' estimate was between 327 - 373 Pg C, which was within the range of previous estimates.

Additionally, from our internal discussions of this, we realized that the labelling of the two approaches (*Page1.5m* and *Page2.3m*) could be confusing as it sounds like that means the depth is somehow from that publication and not PeatDepth-ML. To enhance clarity, we have changed the short names to *Page1.5* and *Page2.3 and made* edits to the final sentences at the end of Section 2.5 *Calculation of Global Peatland Carbon Stocks (new text in bold)*:

We also tested OC and BD values from two Page et al. (2011) approaches. Both methods use tropical OC and BD from their literature review, while employing high-latitude C_{dens} values based on Immirzi et al. (1992) estimates (assuming 1.5 m average peat depth; ***termed 'Page1.5'****) for one method, and recalculating high-latitude Cdens by combining Immirzi et al. (1992) data with 2.3 m average peat depth from Gorham (1991) for the second* ***(termed 'Page2.3'). These two approaches yield high-latitude C_{dens} values of 73.30 kg C/m^3 and 63.74 kg C/m^3 for Page1.5 and Page2.3, respectively.***

Finally, the global total peat C estimate could be compared more extensively with published estimates (Sec. 3.4) and reasons for the relatively low number presented here (outside the range of published numbers, see refs. 1-6) could be discussed.

We do compare our results extensively with other published estimates (please see Fig 13 above). Our results fall within the range of other studies, especially if one considers across the range provided by Peat-ML and GPM.

Best regards,

Joe Melton for the author team

Literature cited:

Greifswald Mire Centre (2022) Global Peatland Map 2.0. Underlying dataset of the Global Peatlands Assessment - The State of the World's Peatlands: Evidence for action toward the conservation, restoration, and sustainable management of peatlands, Global Peatlands Initiative, United Nations Environment Programme, Nairobi.

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Xu, J., Morris, P. J., Liu, J., and Holden, J.: PEATMAP: Refining estimates of global peatland distribution based on a meta-analysis, Catena, 160, 134–140, https://doi.org/10.1016/j.catena.2017.09.010, 2018.