Second round of revisions that were applied for "Cutting peatland CO_2 emissions with water management practices" – Biogeosciences Discussions

We thank the associate editor for his decision to proceed with the discussion on our manuscript. Also, we thank both reviewers for their feedback on the article. We have already responded to reviewer 1, who recommended our manuscript for publication, and adapted our manuscript accordingly. Here, we specifically address the feedback of reviewer 2 who was less positive and recommended rejection. First, we respond to the comments, then we address the changes we applied in this second revision.

The main criticism of reviewer 2 is that the modelled daily potential respiration rate cannot be compared with daily measured fluxes, as the short-term carbon cycle and vegetation dynamics are not represented by the model. This is indeed a very fundamental point, but to us it also shows that reviewer 2 did not fully grasp our approach. In our manuscript we use the measured R_{eco} twice.

1) For each of the 2 years and four sites we add up all daily R_{eco}, GPP and harvests to derive a yearly estimate of the carbon oxidized from the peat (NECB). We cut up the individual years (i.e., at January 1st) and assume that differences in the short-term carbon stocks (grass, roots soils) between years are small compared to the year-round carbon oxidized from the peat and the uncertainty thereof. Using measured yearly NECB as a best estimate for the loss of carbon from peat is a very common approach. This has also been done in Evans et al. (2021) and in Tiemeyer et al. (2020). The model introduced in this paper was validated on NECB of two years (a dry and wet year) from four different fields. Relative differences in yearly averaged potential respiration rate and measured NECB correspond very well (Fig. 7). Hence, this supports the assumption that the differences in storage of young carbon cycle material at the start and end of a measuring/modelling year are small compared to the uncertainty in NEE and harvests (Sect. 2.1.4).
2) We do compare measured daily R_{eco} with computed daily potential respiration rate, but the goal of this comparison is only to compare the dynamics of both. We test several water-filled-pore-space (WFPS)-sensitivity curves (relation between water content and potential respiration) that fit the general shape shown from lab measurement by Säurich et al. (2019). The curve that explains most of the observed daily dynamics of R_{eco} is assumed to best represent the effect of soil moisture on respiration, where we indeed cannot distinguish between fast and slow carbon cycle respiration and thus assume the same sensitivity for all carbon pools, similar to the approach of van Huissteden et al. (2006). If our aim would have been to simulate short term ecosystem respiration (R_{eco}), it would indeed matter to account for short cycle carbon, as this would have influenced the magnitude of the flux. However, we only used the R_{eco} *dynamics* to establish the effect of WFPS on potential respiration. Even though short-cycle carbon respiration disturbs the comparison between R_{eco} and potential respiration we find high correlations. We know that the shape of the curve is bound by experiments in literature, and we also apply a sensitivity analysis to support the choice for our WFPS-potential respiration curve. Therefore, we think that our approach is actually a step forward in addressing the peat respiration sensitivity for soil moisture under field conditions.

In short: In contrast to what reviewer 2 states, we do not use modelled daily potential respiration rates to represent measured daily R_{eco} anywhere in our manuscript. Based on the comments of reviewer 2, we do now make another effort to make this distinction extra clear within the manuscript.

When designing the research, we aimed for a model that consists of a low amount of parameters. Indeed, the young carbon pool could be modelled, as was done in some of the articles that reviewer 2 suggests, but adding complexity to models is not inherently leading to better model results due to a higher amount of parameters. The added complexity might induce problems such as equifinality and increased uncertainty due to parameter estimation.

It seems that reviewer 2 addressed a mistake that was made while converting the potential respiration to NECB in line 482 (Sect. 3.5.1). We thank reviewer 2 for noticing this. However, by definition of our approach (relating the modelled yearly potential respiration to the observed yearly NECB with a linear conversion) there is no bias between modelled and observed NECB (Eq. 5).

Reviewer 2 argues that other vegetation types would expose the effect of the short-term carbon cycle. Indeed, we think that a different vegetation class would change the magnitude of R_{eco}. However, a natural system would also have different soil/peat characteristics that influence the decomposition. We specifically studied drained agricultural peat meadows within this research and natural systems were beyond our study scope.

The reviewer argues that without modelling C-input it is not possible to obtain changes in the C-stock of peatlands. We disagree with his argumentation. The fact that the observed NECB and the modelled yearly potential respiration rate align so well indicates that indeed our approach has great potential for simulating yearly decomposition fluxes from agricultural drained peat soils. Also, the assumption of differences in short-term carbon stocks between the start and end of the measuring/modelling years does not seem to affect our results given the high rates of peat decomposition found in these agricultural drained peatlands. Thus, there is no reason for suspecting large errors or flux imbalances.

Changes

- We elaborated upon the measurement and modelling assumptions related to the short carbon cycle within Sect. 2.1.4, 2.2.2, 2.2.3, 3.4.1.
- We elaborated upon the differences between the comparison of R_{eco} and potential respiration rate, and the comparison of the NECB (including Reco) and yearly potential respiration rate within Sect. 2.2.3.
- We corrected for the conversion error in the first sentence of Sect. 3.5.1 and checked other conversions throughout the article.
- We corrected for two typing errors in Eq. 5: the '±' sign should have been a '+' and the intercept *0.269* should have been *0.259*.