

Interactive comment on “Coupled eco-hydrology and biogeochemistry algorithms enable simulation of water table depth effects on boreal peatland net CO₂ exchange” by Mohammad Mezbahuddin et al.

Anonymous Referee #2

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General Comments The manuscript addresses impacts on CO₂ fluxes from changes in water table depth by using the ecosys model. The model is tested with eddy covariance and chamber CO₂ fluxes from a boreal peatland field site. The manuscript is dense throughout and requires very careful attention on the part of the reader to follow along. While the ecosys model is complex, how this paper is written exacerbates the complexity of the model. Right now, this paper would be an incredibly useful guide to someone wanting to run the ecosys model themselves, but lacks a clear and story that is supported by the results of this work.

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The major issue I have with this work is the relative complexity of the ecosys model next to the small amount of observed data that the model is compared with. Since ecosys has so many moving parts “under the hood”, I can’t say that I’m surprised at all to see it match data as well as it does. A good fit to observed data is not a new finding itself, and in a broader sense, the research questions aren’t new. In fact, there is a good amount of overlap with Mezbahuddin et al. (2016), as brought up by Referee 1. So, I’m stuck reading through a dense description of a complex model, and at the end, it’s compared with limited amounts of data that itself is modeled. The main conclusions seem to be focused on internal modeled variables within the ecosys model that have zero comparison to data. The major conclusions are changes in modeled O₂ diffusion, N mineralization rates, nutrient availability, microbial concentrations, plant functional type GPP. These results, as currently presented, are simply not supported by comparing to net CO₂ fluxes.

The authors state in the conclusions that “These modelling hypotheses were also corroborated by various field, laboratory and modelling studies over similar peatlands (Sect. 4.1)” but the reader is left to dig out bits of information through the entire discussion section. At a bare minimum, for me to trust the conclusions of this work, the authors must provide a clear and succinct comparison of their model parameters to literature values in a table/graph, including error analysis. Also, asking the reader to trust your conclusions because they match literature is fine, but there is a major issue when the story of the paper is that inter-site variation of peatland sites is high.

Specific Comments To expand on the above general comment, the eddy covariance and chamber data is not explained well enough in this paper. Let me be clear, that doesn’t mean that I have issues with the data itself, just how it is presented and used here. Referee 1 brought up the issue of comparing model output to gap filled data, which is comparing a model to another model. That is absolutely an issue in this work, and I second what Referee 1 highlights as a major issue, but I’ll go further. There needs to be more discussion of the data, how it was gap-filled, possible sources of

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error and what that means when compared to the model results. I know this is a modeling work, but with very limited observational data to compare the model results with, simply saying in two sentences “To examine how well ecosys simulated net ecosystem CO₂ exchange at the WPL, we tested hourly modelled net ecosystem CO₂ fluxes against those measured by using eddy covariance (EC) micro-meteorological approach by Syed et al. (2006) and Flanagan and Syed (2011). Quality control, and gap-filling of EC measured net CO₂ fluxes, and partitioning of EC-gap filled net CO₂ fluxes into GPP and Re were done by Syed et al. (2006) and Flanagan and Syed (2011)” is not enough when the first line says “we used observational data” and the second says “please read those other papers for their methods”. Now, when we get to the details of the chamber fluxes, there are slightly more details, but again, not nearly enough. Again, you partition net CO₂ using a model, but don’t explain anything beyond that. You average over 9 chambers, but don’t say why or what that means? How much error is introduced here? What is the range of observed fluxes? The reader doesn’t know, so again going back to my main issue, with very limited observational data, ecosys modeled results look good at the surface, but the work is limited in how much the reader can trust the results of an over-parameterized and under-tested model.

Once we move past the issue of how the observational data is described, we move through a lot of model descriptions and results that are very, very dense. I’m very happy to see what looks like the full set of equations that go into ecosys in the appendixes, but the reader is left with only very dense blocks of text to try to figure out what parts of the model are important and why. I would suggest keeping the entire set of equations in the appendix, but moving the main equations used here into the text of the manuscript. Then, the reader doesn’t have to dig out the equations for context and, more importantly, it would be easier to focus the story around those few equations. As the reader is starting to get a handle of the main story presented, a major issue comes up again. There isn’t enough data to support the conclusions. Even the highlighted results in the abstract are heavily focused on things like nitrogen dynamics, nutrient mineralization, GPP of plant functional types, all of which are 100 percent internal to

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the model without any space in the manuscript devoted to why the reader should trust the internal model equations.

Finally, the conclusions presented are simply changes in variables that are internal to the model, without anything to compare them with other than literature values from other studies. As mentioned in the general comment above, the literature values could be a valid check if done well, but as this manuscript is currently written, that needs to be done more formally and not in the discussion. With the suggestion of strengthening the comparison of the modeled conclusions to literature as well as the authors pinning a lot of the trust in their conclusions on said literature values, when the ending of the introduction/justification section is as follows: “Moreover, since hydrological feedbacks to key peatland C processes are highly non-linear and site-specific, testing of ecosys algorithms across contrasting peatlands would also facilitate formation of a modelling platform for scaling up simulations of those feedbacks across peatlands at larger spatial scales i.e., national, regional, continental or global as also recommended by Waddington et al. (2015)” the reader is going to be confused. On one hand, you compare your conclusions to literature and say “look, these results fit with other studies” but the entire paper was setup with the story of “there are lots of variations across peatland sites” throughout the introduction. So, I’m confused and this needs to be cleared up either by heavy editing of the story.

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