

## Report on: Modeling the impact of drainage on peatland CO<sub>2</sub> and CH<sub>4</sub> fluxes and its underlying drivers.

Whilst there are existing site-scale peatland models that simulate drainage in peatlands and its effect on peat Carbon, this paper reports on interesting work to represent peatland drainage in a land surface model (ORCHIDEE-PEAT). However, following its revision, I still have concerns about the approach taken to presenting the model and its results. The paper represents a first step in model development, which the authors acknowledge, and it should be presented as such.

The authors clearly and fully report on the limitations of the new model's limitations when simulating drainage. However, these limitations illustrate that claims about using model predictions as a tool "for estimating drainage effects" are probably not appropriate at this stage. Instead, the limitations should be framed around the steps needed to better represent peatland drainage in a land surface model, what the challenges are, and how they might be addressed.

I agree with the comments from the two previous reviewers and won't repeat those here. However, my concerns (written before reading the previous reviews) were very similar to those already raised. Therefore, in my view, the framing of the revised manuscript should:

- Have greater focus on the drainage module and approach, which I think is still inadequate, since that is the novel addition presented here.
- Consider a different title: e.g. The development and implementation of a drainage module for ORCHIDEE-PEAT.
- Discuss what happens to peatlands when they are drained and what will or won't be simulated here.
- Discuss how other site-scale peatland models simulate drainage and compare them with the approach implemented here. Identify some of the key issues that need to be solved at some time.
- What are the challenges of implementing drainage in a LSM in comparison to site-scale models.
- Talk about the detail needed in the model. Additional complexity isn't always a good thing and can just increase the uncertainty of model predictions. Perhaps the authors can identify how they might tackle this issue.
- Highlight the progress made, and
- talk about and prioritise the next steps in model development.

In my opinion, the manuscript deserves to be published, but not in its current form.