

Hydrol. Earth Syst. Sci. Discuss., referee comment RC1
<https://doi.org/10.5194/hess-2021-585-RC1>, 2022
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Comment on hess-2021-585

Joshua Ratcliffe (Referee)

Referee comment on "Water level variation at a beaver pond significantly impacts net CO₂ uptake of a continental bog" by Hongxing He et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2021-585-RC1>, 2022

In this manuscript the authors investigate how the management of a beaver dam has affected the lateral flow of water, and the vertical CO₂ fluxes, from a well known and long-running GHG monitoring site at Mer Bleue peatland. They use a modelling approach to provide several 'what-if' scenarios to model what the CO₂ flux may have been without any alteration of the beaver pond level.

This is a very innovative paper which addresses an important and overlooked aspect of the peatland GHG flux, i.e. what is going on at the margins. It will additionally be good to see this published as it concerns Mer Bleue, the longest running EC record on a boreal peatlands and a site from which much of our understanding of boreal peatland ecology and gas flux is derived.

I really like the approach the authors have used to tease out the effect of the beaver pond from the background variability. I think it is clear from the measured data in Figure 2 and Figure 3 and Figure 6 that there was a major change in the ecosystem corresponding with the rise in the water level of the beaver pond, the coup model nicely confirms this as a mechanism.

Importantly, this confirms the wide-ranging ecological effects water table management can have hundreds of meters from the flux measurement site. This has important implications for other sites and boreal ecosystems, including other long-running flux measurement sites. I know some researchers who work on relatively degraded peatlands, with low horizontal hydraulic conductivity, who are sceptical that water level management hundreds of meters away can have any affect at all and I think it would be good to discuss how Mer Bleue might contrast to other peatlands. See my comment to this further below.

The coup model itself preforms adequately, and the authors discuss the limitations of the

model in appropriate detail.

While I generally think this is a very good paper, I thought it was lacking some detail which would ensure its comparability to other sites and situations. While hydrological feedbacks are mentioned, it's not really clear just how strong these feedbacks can be. In the discussion I would like to see a short paragraph about the horizontal hydrologic conductivity and how Mer Bleaur compares to other peatlands and how we might expect this to change if the water table was to undergo sustained lowering for a period of decades or more.

One thing that bothers me rather a lot is that the increase in ER with the beaver pond level listed in Figure 7 seems to contradict what was established in Lafleur et al., 2005 (Ecosystem Respiration in a Cool Temperate Bog Depends on Peat Temperature But Not Water Table) where water table fluctuations were found to have little or no effect on ER, this is maybe due to Lafleur et al., 2005 only having the early data available, before the beaver dam raising, but I would like to see this addressed. At the moment this paper is not cited.

Additionally, I have a comment about the measured data. I do not believe (nor would it be correct) that the methodology used to process the fluxes is the same as in Roulet et al., 2007. There have been several large changes in best practice for flux processing in the last 15 years that I am sure the authors are aware of. I would like to see the detailed method for flux processing included in the SI

Could the authors state why the flux simulations in 2013 and 2017 performed so poorly compared to other years?

I wish the authors the best of luck with the revisions.

Figure 2:

Should be clear what is generated data and what is measured. Suggest the generated data is presented in a different colour/style

The measured water level at the peatlands also looks rather spiky and a bit suspect (2006 and 2007). Please check for and remove outliers if present. It would be good to state the

temporal resolution in the caption.

Other than this I have some minor comments the authors may wish to consider.

L9: should be "feedbacks"

L12: consider "lateral flow of water"

L29:30 This range listed is too low, see the following. Suggest an upper range of ~200 g m⁻² yr

<https://doi.org/10.1111/gcb.13424>

<https://doi.org/10.1111/j.1365-2486.2010.02378.x>.

L54-L55: There are a few analogous studies looking at road construction and how that have raised and lowered water table levels for instance:
<https://doi.org/10.1007/s10021-016-0092-x>

L83: Should mention that it is a downward slope (being a bog I would assume so...)

L101 Please state the total number of periodic measurements (n=?)

L103: This is probably fine, given the change in mean across treatments. Please differentiate this data somehow in the plots (particularly in Figure 2)

L207: Really nice to see these numbers!

213: suggest "the disturbance level"

226: Water table is relatively meaningless over winter, not really a problem.

240: Again, it would be worth discussing (briefly) how the shrub dominance of GPP at Mer Bleue might cause it to respond differently to other peatlands, see discussion in <https://doi.org/10.1016/j.scitotenv.2018.11.151>

L339: Other sites see very large changes, see <https://doi.org/10.1111/jvs.12602>

L341: suggest also the following as a site where there has been major changes in GPP and plant cover following WT lowering <https://doi.org/10.1016/j.scitotenv.2019.134613>

L384-385: These models are almost totally useless without incorporating feedbacks.

L387: This is a reasonable statement, I agree.

L390: I'd say this is not as well established as it might be believed there are odd sites such as pocosin and restiad peatlands where C accumulation can be high even under a very low water table again see: <https://doi.org/10.1016/j.scitotenv.2018.11.151>

