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Interactive comment on "Drought years in peatland rewetting: Rapid vegetation succession can maintain the net CO_2 sink function" *by* Florian Beyer et al.

Anonymous Referee #2

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Beyer et al. analyse the impact of a drought year on the CO2 fluxes of a rewetted fen. They test if drought can hinder the success of peatland rewetting and find that even in a drought year the net CO2 function of the fen can be maintained. They suggest that the increased GPP related to vegetation encroachment in previously open water surfaces compensates partly for the increase in ecosystem respiration.

The manuscript aims to improve our current understanding of vegetation succession following rewetting of fens and specifically of the role of droughts in the success of rewetting efforts. The authors present an interesting mechanism that could explain how rewetted fens respond to droughts. The manuscript is well written, and the authors use

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a range of different methodologies to tackle their research question. However, I have a few comments that the authors should consider addressing.

I am wondering if the results of this study can be generalised. The authors present an interesting case study, but it could be that specific site characteristics and the specific drought characteristics were mainly responsible for the observed responses in CO2 fluxes. The authors mention that the water table in spring 2018 was unusually high due to the previous year's high precipitation. This apparently led to a discrepancy between meteorological drought (mainly in May) and hydrological drought (from August on when the water table dropped below the surface). This specific setting might be responsible for the high GPP rates early in the growing season (see Fig. 5a). If the meteorological and hydrological drought would co-occur, a negative effect on GPP could be possible potentially leading to the fen becoming a net CO2 source. This hypothesis might be difficult to test with the existing data, but the authors might consider discussing this scenario.

The authors use MODIS EVI data in their analysis. Using remote sensing data would also allow them to quantify the vegetation response at other rewetted peatland sites in the region and would make their findings more generalizable. If near-natural fens exist in the region, the authors could also use a "reference site" to analyse the different vegetation responses between a rewetted and an intact system. I think this approach would provide additional evidence that the observed ecosystem responses can be generalised.

The authors quantify the immediate drought effects on vegetation dynamics and CO2 fluxes. However, as they point out in the discussion, it remains unclear what the long-term effects of this drought will be. Will the newly established vegetation survive in a following year with extended flooding? They discuss this issue briefly in their last paragraph. However, I think it would be beneficial to at least assess how EVI and/or CO2 fluxes in 2019 were affected by the 2018 drought if such an analysis is feasible.

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Other comments Line 25: Consider using “short-term climate warming”.

Line 50: Are there any drought studies for fens? It would be helpful to shortly summarise the current knowledge of drought impacts on carbon cycling in fens. Here are a few examples of fen studies:

Knorr et al. (2008): https://doi.org/10.1016/j.soilbio.2008.03.019

Robroek et al. (2017): https://royalsocietypublishing.org/doi/10.1098/rsos.170449

Olefeldt et al. (2017): https://doi.org/10.1111/gcb.13612

Schreader et al. (1998): https://doi.org/10.1029/98GB02738

Line 153: What was the overlap between eddy covariance flux footprint and MODIS pixel?

Line 163: Is it possible to quantify how much the increased light availability contributed to enhanced GPP? This could be done by comparing light-response curves. Even with similar light response curves, GPP could be different in 2018 due to differences in light availability.

Line 220: The authors could consider comparing so-called carbon uptake periods between the drought year and other years:

For example: Fu et al. (2017): https://doi.org/10.1016/j.agrformet.2017.05.009

Fig. 5c: Adding a 7-day moving average line to the graph would make the seasonal variations more visible.

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