Biogeosciences Discuss.,
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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.

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General response: Dear editor, dear reviewers, your thoughtful comments and constructive suggestions will be extremely helpful in further improving the manuscript. In particular, the reviewer's suggestion to include CH4 data will broaden our perspective on drought effects in our study site (see new Figure 1). We will add a statement on the relevance of CH4 emissions for short-term climate effects due to rewetting in the introduction and add CH4 flux data from 2011 onwards to the study. As explained below, our data do not allow us to derive more information about possible effects during the post-drought year 2019, but we agree, that we could use the existing data more efficiently to extend our mechanistic understanding of drought-related processes. We will therefore test empirical modelling approaches that include (i) multiple regression using carbon uptake periods as a potential control variable and (ii) light use efficiency modelling. The reviewer's suggestions were also very helpful to stimulate new thoughts on the practical relevance of our study, which will be included in the Introduction and the Discussion section. As an example, we will relate our study to existing uncertainties in nature-based climate solutions to achieve the mitigation targets under a changing climate. Furthermore, our data suggests the importance of peatland rewetting to create hydrological retention areas as important prerequisite for landscapes resilient to climate change. Kind regards, Franziska Koebsch/Florian Beyer

In the following we respond to the individual comments of Reviewer 2 (RC2):

Comment 1 We think that the reviewer is right in his/her suggestion that the filled water reservoirs from last year's high rainfall contributed to the postponement of the hydrological drought and could thereby buffer the effect of the meteorological drought. The restoration of minerotrophic fens creates hydrological retention areas that slow down runoff, keep the water in the landscape longer and, additionally, decrease the surface temperature (Hemes et al. 2018). We think that this is another important plea for peatland rewetting that should be included in the manuscript: Not only showed the studied fen regulatory mechanisms to cope with temporary droughts, the restoration of fens also increases the resilience to drought on landscape level. Hemes, K. S., Eichelmann, E., Chamberlain, S. D., Knox, S. H., Oikawa, P. Y., Sturtevant, C., ... & Baldocchi, D. D. (2018). A unique combination of aerodynamic and surface properties contribute to surface cooling in restored wetlands of the SacramentoâĂŘSan Joaquin Delta, California. Journal of Geophysical Research: Biogeosciences, 123(7), 2072-2090.

Comment 2 You are absolutely right that remote sensing is a suitable tool to scale the described processes. However, we think that the major benefit of this study is the long-term reference data set on vegetation development and greenhouse gas exchange, which allows to discriminate the effects of the summer drought 2018 from climatenormal years. We think that, by including additional data on CH4 emissions (see new Figure 1) and empirical modelling, we can provide a deeper understanding on the drought-related processes at this study site.

Comment 3 (Same answer like Comment 3 of Reviewer 1) We understand that the addition of 2019 data in general would be helpful to better constrain carry-over effects of the drought. However, in January 2019 the area was flooded with brackish water from the adjacent Baltic Sea, which substantially affected the biogeochemistry of the peatland including vegetation and greenhouse gas exchange. The conditions in 2019 will therefore be determined by both brackish water intrusion and possible effects after the drought, and we are unfortunately not able to clearly assign the observations in 2019 to either of these two factors. In order to prevent false conclusions on post-drought effects, we refrain from including 2019 data.

Comment 4 Your comment is in line with reviewer 1 and as we will add CH4 flux data in this study we will provide a more detailed description of the climate impact of CH4 emissions.

Comment 5 Many thanks for your hint and the links. These studies do indeed contain some valuable information on drought processes in fens, which we will add to the introduction. Nevertheless, this selection also shows that most of our knowledge about drought effects in fens comes from treatment experiments and pristine sites. There are few natural observations, especially of restored fens, whose ecosystem functions and drought response mechanisms might substantially differ from those of natural sites.

Comment 6 You can see the overlap in Figure B2 (Modis Grid in blue, Eddy footprint in yellow). We'll add one sentence in line 157:"(. . .)Values were ïňĄltered according to pixel reliability and pixel-wise quality assessment and data gaps were subsequently ïňĄlled by linear interpolation. The used MODIS pixel and the 90% footprint of the Eddy Tower are almost completely overlapping, as shown in Figure 2B.

Comment 7 We think this is a great idea to enhance our mechanistic understanding on

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drought effects on GEP. In addition to multiple regression, light use efficiencies will be one modelling approach to be included in this study.

Comment 8 We agree that carbon uptake periods can provide additional insights into the processes that control the CH_4 and CO_2 exchange during drought. We will therefore implement carbon uptake periods as potential control variable in our multiple regression model.

Comment 9: All Figures of GEP, Reco, NEE and CH_4 are now changed according to the suggestions of RC2 (7 days moving average of 2018 (black) as well as for the mean pre-drought period (dark gray)). Please see the new Figures.

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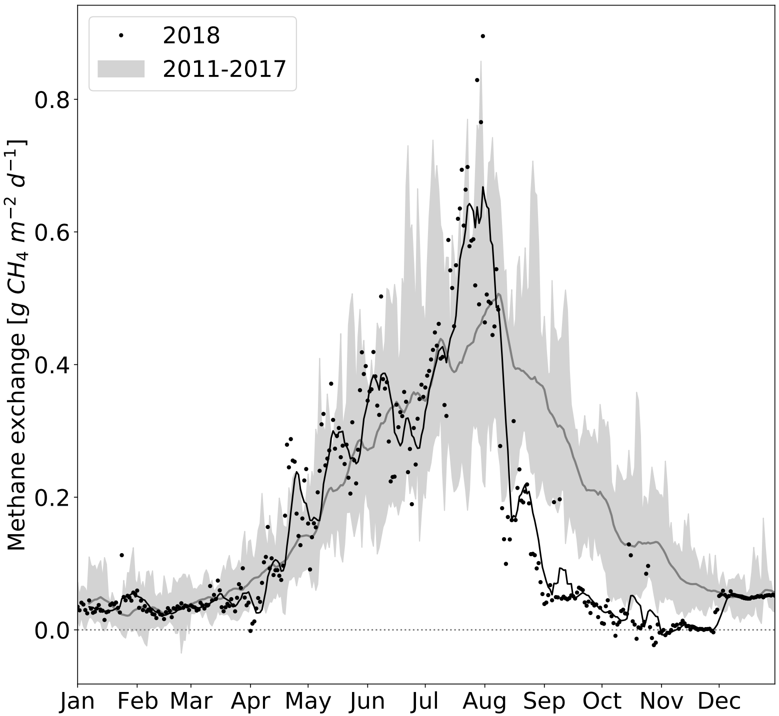
2018
2011-2017
0.8
0.6
0.4
0.2
0.0
Methane exchange [$g\ CH_4\ m^{-2}\ d^{-1}$]
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Fig. 1.

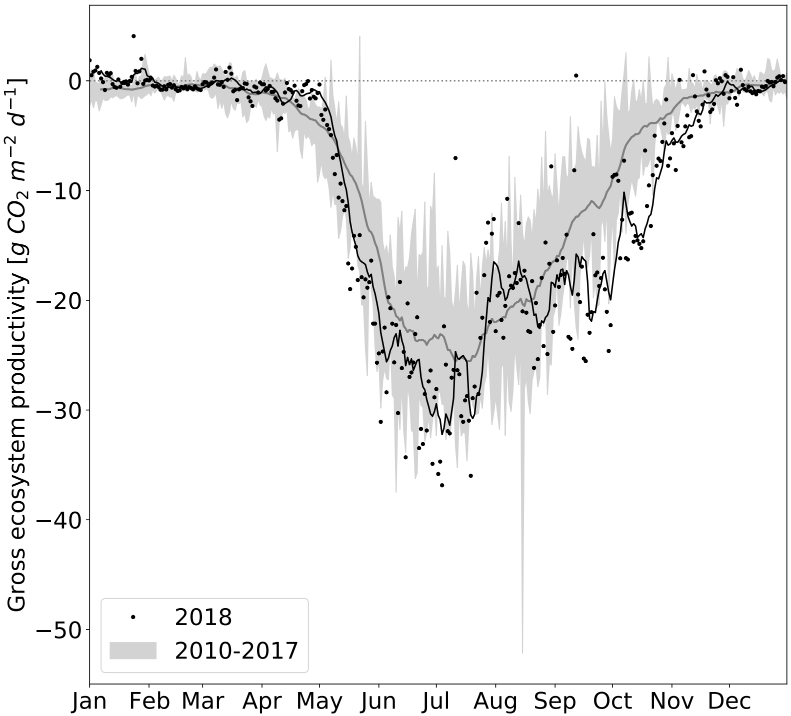
Gross ecosystem productivity [$g\ CO_2\ m^{-2}\ d^{-1}$]
0
−10
−20
−30
−40
−50
2018
2010-2017
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Fig. 2.

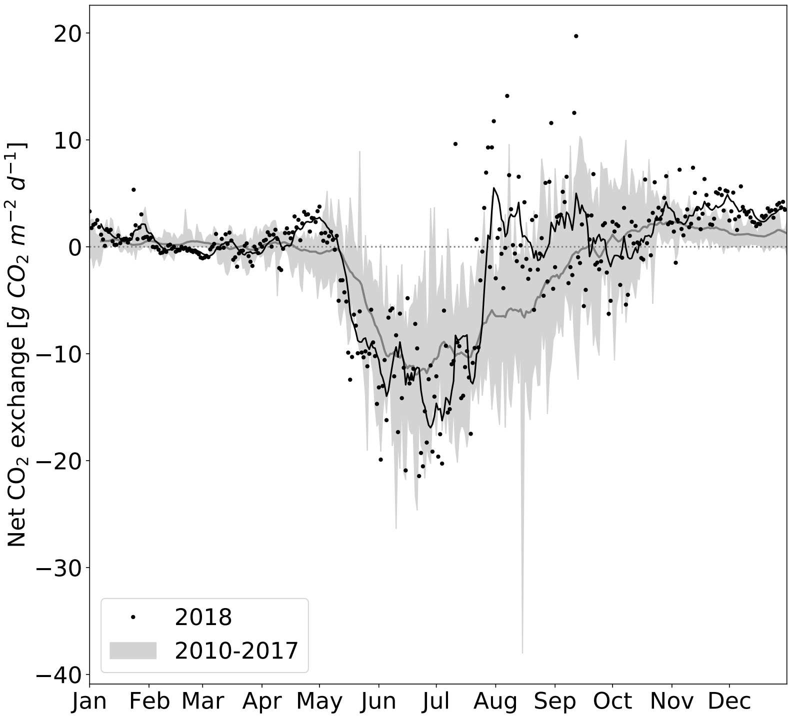

Fig. 3.

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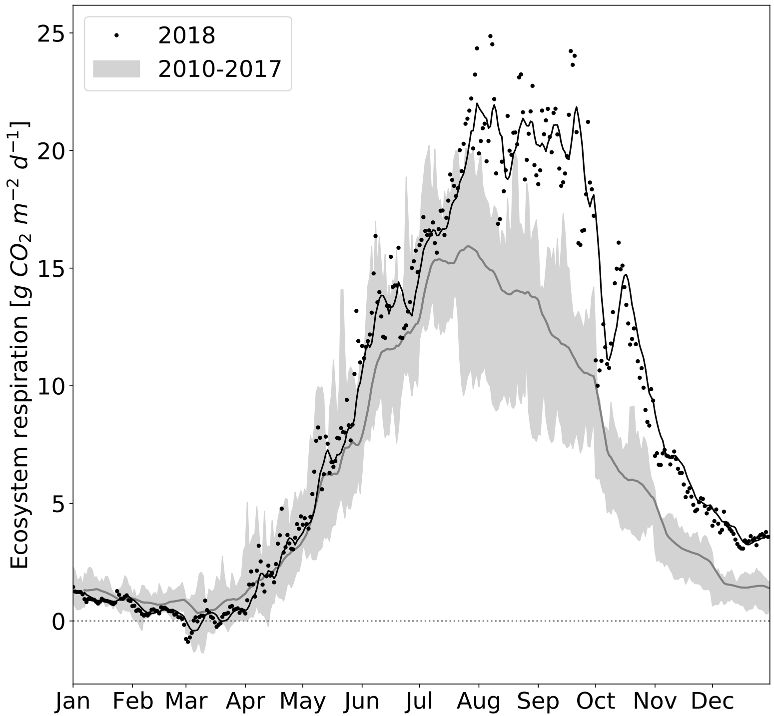

Fig. 4.

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