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Biogeosciences
Discussions

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

Florian Beyer et al.

florian.beyer@uni-rostock.de

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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 effi-

ciently 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 1 (RC1):

Comment 1 We agree: adding more context on nature-based climate solutions and the existing uncertainty to reach the mitigation targets under a changing climate would certainly increase the impact of the study. The reviewer's literature suggestions will be very helpful in amending the introduction accordingly.

Comment 2 Although the primary climate mitigation effect in peatland rewetting is due to the switch from a CO2 source to a CO2 sink, we decided to add CH4 flux data to our study (see new Figure 1). Therefore, we will add to the introduction a description of the role of CH4 in occasional droughts. We will also add a passage on N2O, although we cannot provide N2O data from the drought period. We have measured N2O fluxes in 2009 and 2010, in the last year of drainage (dry conditions) and in the first year of rewetting (wet conditions). These data indicate that N2O fluxes were negligible under both hydrological regimes.

Comment 3 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 We agree that the observation data provide a good opportunity to deepen our mechanistic understanding on drought effects. We would therefore apply the following approaches and include the results in our manuscript: - a multiple regression model that allows the comparison of effect sizes as indications for varying sensitivities over different observation years -a light use efficiency model to better constrain potential drought-related limitations in plant photosynthesis

Comment 5 Line 27 We chose to include methane data (see new Figure 1), as another relevant greenhouse gas and present the relevance of methane for short-term climate impacts in the introduction.

Comment 6 Line 37 Indeed, our data suggest that there is a distinct reduction in methane emission after water levels decreased below surface. These data will be included in the study (see new Figure 1).

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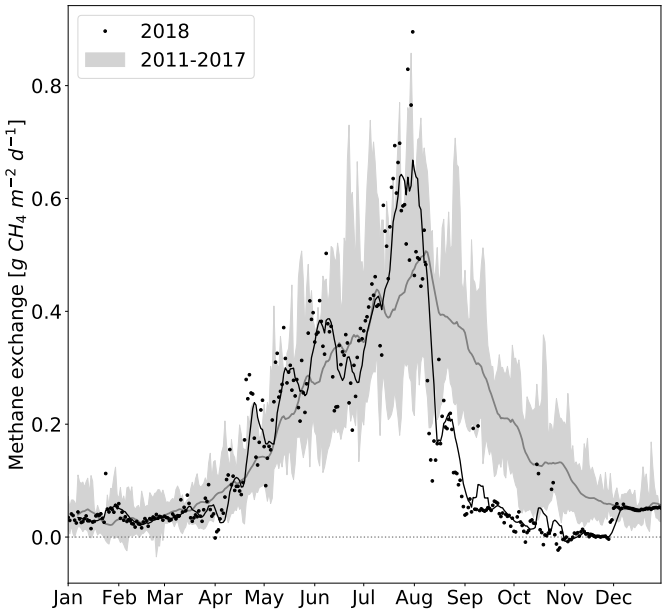

Fig. 1.

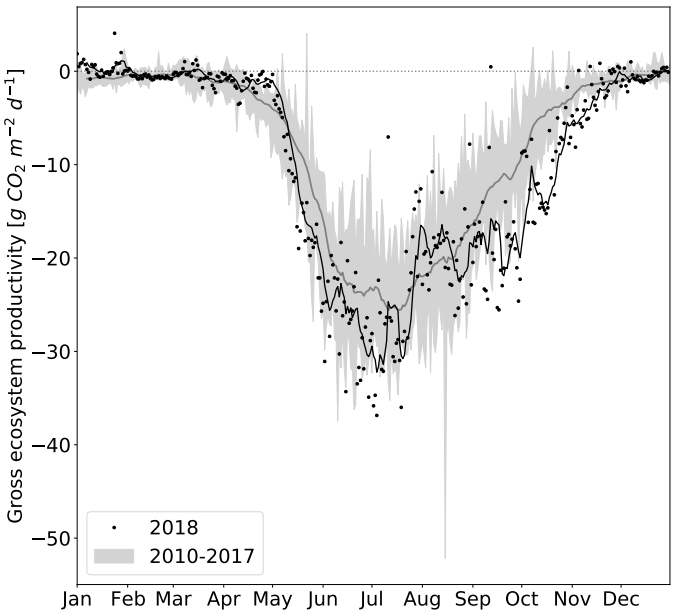
Gross ecosystem productivity [g CO_2 m^{-2} d^{-1}]
0
−10
−20
−30
−40
−50
2018
2010-2017
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Fig. 2.

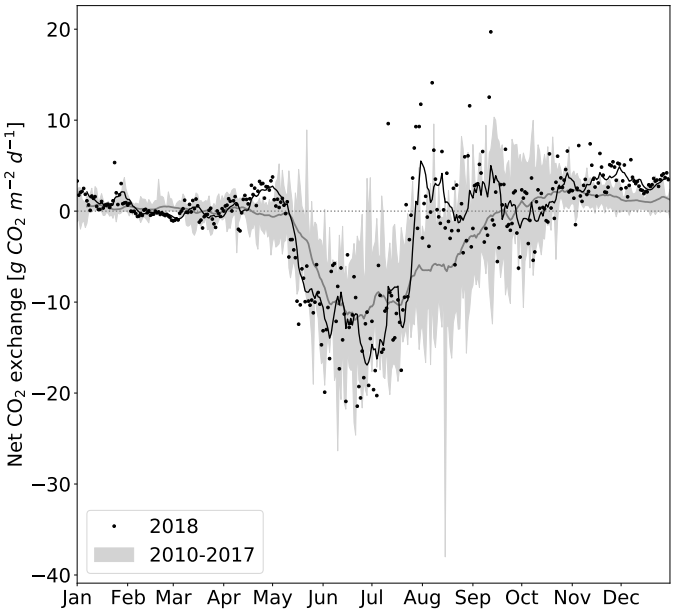
Net CO_2 exchange [g CO_2 m^{-2} d^{-1}]
20
10
0
−10
−20
−30
−40
2018
2010-2017
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Fig. 3.

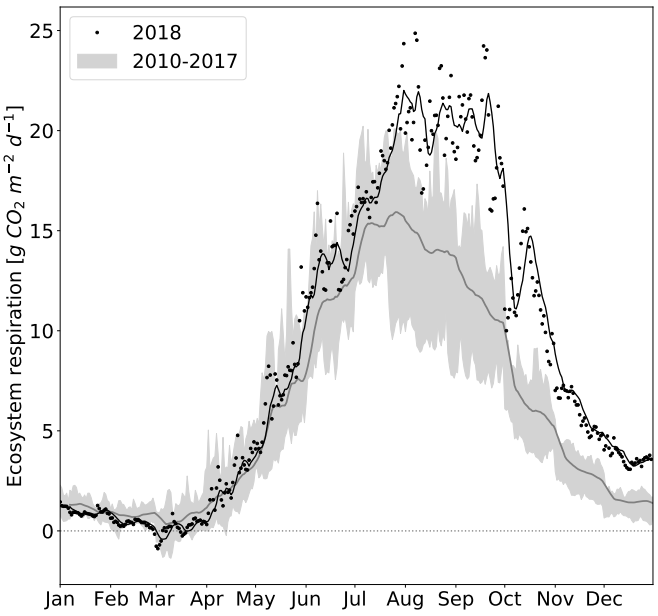
2018
2010-2017
Ecosystem respiration [g CO_2 m^{-2} d^{-1}]
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Fig. 4.