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Interactive comment on "Greenhouse gas emissions from fen soils used for forage production in northern Germany" *by* A. Poyda et al.

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Major comments

Poyda et al. addressed a very interesting question that how management and drainage intensity influences the greenhouse gas emissions from fen soils of northern Germany that are used for forage production. Research questions are important with respect to the current agricultural practices in this area. This is a timely study in light of the projected climate change and the importance of northern peatlands as a potential source or sink of atmospheric C.

The methods used for flux measurements and modeling are standard, statistical part

is described quite well. The study was done for three growing seasons, which helped to interpret the interannual variability of GHGs flux data. I like the idea of calculating the yield-related GHGs fluxes. In general, they reported that most important controller for GHGs emission in this system was long-term drainage intensity. Rewetting of this peat-based system reduced the overall global warming potential, but, still, the unutilized grassland (UG) act as a weak C source and a considerable amount of N2O was emitted to the atmosphere from UG site, and, highlighting the need to continue the effort to restore to the natural condition. The finding that the wet grassland has a potential for significant reduction in GHGs emission without removing the ongoing cultivation practices of forage crop should be of broad interest.

Specific comments and technical corrections:

P5, L22: "agriculturally" instead of "agricultural".

P7, L12: Place comma after "In these areas".

P8, L24: How long the oven drying of soil was done to estimate the gravimetric water content. It usually takes 24 hours at 105°C, but it is better to mention the duration.

P8, L25-28: How did you calculate organic C content from the elemental analyzer? The combustion method used in the elemental analyzer usually gives an estimate of total C. You can do acid digestion prior to the combustion step in order to eliminate the inorganic C or offline calculation can be done for organic C. If the assumption is that the peatland is mostly organic soil, then the estimates of loss on ignition are warranted. Please clarify this issue. Also, mention the time taken for oven drying of the samples at 40°C.

P9, L29: Is it normal to collect flux measurements between 9am to noon in these areas? When do you expect to see the peak in the diel pattern of CO2? Peak in the CO2 flux often lags by few hours with respect to the peak in the soil temperature in temperate and boreal forests (see Gaumont-Guay et al., 2006 and Savage et al.,

2009) due to a delayed response to the aboveground processes. The time lag in the agricultural system may be much less, if any. Also, to capture the daily mean value, you should take representative readings before and after the flux value peaked. An explanation on this may be of worth to support the sampling time used in this study for a representative mean daily flux.

P11, L8: What were your criteria for the acceptance of the CO2 flux data? Did you follow the same approach like CH4 and N2O flux data for the coefficient of determination?

P12, L23: What do you mean by “own examination”? Please explain briefly.

P13, L1-23: The equation for NEE is little confusing for the general reader. I see that you have mentioned the sign convention of individual flux components in L 19-21. But, it is better to write NEE=GPP-R_ECO and rephrase in the previous line that NEE was calculated as the difference (not sum) between GPP and R_ECO. It is better to maintain the conventional sign of flux: positive flux as a source to the atmosphere (which R_ECO is) and negative flux as a sink to the ecosystem (which GPP is) and the net balance of these two ultimately determine whether the ecosystem serves as a source (positive NEE) or a sink (negative NEE) for CO2.

P13, L27: It will be worth exploring if the Kolmogorov-Smirnov Goodness-of-Fit Test for normality of data corroborates with the graphical residual analysis, especially for CH4 and N2O, which are often characterized by hot-spots or hot moments.

P22, L3-10: In general, fluxes of N2O (and CO2) have been reported in literature after thawing of frozen soil due to the release of stored labile C and nutrients. The buildup of these labile substrates during freezing event usually comprised of dead microorganisms, dead fine roots, and C released from the breakdown of aggregates. Also, the response often depends on the intensity and duration of freezing as well as the soil properties. So, please explain clearly your point on the pulse of N2O during the freezing event, in addition to the thawing event afterward? Also, it has been reported that

the successive pulse of N2O has been reduced with increased frequency of freeze-thaw cycle, which may explain the lower winter fluxes in the second year. See Xu et al. (2016) and the articles cited in the reference list for more details.

P22, L11-20: Please note the prerequisite for the release of N2O in the incomplete denitrification process (where, complete denitrification: NO3- -> NO2- -> NO -> N2O -> N2) is the onset of anoxic (or reduced) condition. Do you have evidence that the N2O emission was greatest from nitrate-rich soils (or soil microsite) with relatively greater water filled pore space?

P24, L2: Check sentence. Consider “. . . would, therefore, . . . before increase the total productivity. . .”

P24, L8: Consider “. . . source or sink of CO2. . .”

P28, L27: Place comma after “Also”.

P53, Fig. 8: R2 adj for the model is 0.05. Does this mean ground water level and soil temperature at 5cm depth could explain only 5% of the variation in the flux of CH4-C? Please clarify the relevance of the model and what is the interpretation of this figure.

References cited in the review of the article that are not listed in the manuscript: 1. Gaumont-Guay, D., Black, T.A., Barr, A.G., Jassal, R.S., Nesic, Z., 2008. Biophysical controls on rhizospheric and heterotrophic components of soil respiration in a boreal black spruce stand. Tree Physiology 28, 161–171. 2. Savage, K., Davidson, E.A., Richardson, A.D. and Hollinger, D.Y., 2009. Three scales of temporal resolution from automated soil respiration measurements. Agricultural and Forest Meteorology, 149, 2012-2021. 3. Xu, X., Duan, C., Wu, H., Li, T., & Cheng, W. 2016. Effect of intensity and duration of freezing on soil microbial biomass, extractable C and N pools, and N2O and CO2 emissions from forest soils in cold temperate region.Science China Earth Sciences, 59, 156-169.

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