-We thank the reviewers for their positive and constructive comments. Please see below our response to each of the comments.

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Interactive comment on "Carbon dioxide and methane exchange of a patterned subarctic fen during two contrasting growing seasons" by Lauri Heiskanen et al.

Anonymous Referee #1

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In brief, I found paper written very well, with a nice literature review, useful figures, tables, schemes and easy-to-understand English. Methods are state of the art. Ba-sic tools of studying greenhouse gas exchange between atmosphere and ecosystems such as Eddy Covariance and chamber method were used in a proper way. Finland wetlands are investigated on an incredible (best all over the world) level in terms of greenhouse gas fluxes with a lot of possibilities to compare results and to pro-vide extrapolations. In this situation it is really hard to say something new about fluxes from these subarctic mires. In general, two years are not enough for reliable estimates of weather/climate induced effects on carbon fluxes. But I think authors did everything they can to generate new insights about carbon balance and its environmental controls. Therefore the paper definitely deserves publication. I have several minor comments and suggestions to make paper text a bit more clear.

L. 104. Did you miss minus sign here (if you use micrometeorological sign convention)?

- Yes, thank you. Minus sign was added.

L. 122. Please add information, in what year(s) collars were installed on your sites. Did you notice any changes of plant communities inside "the oldest" collars? Sometimes vegetation inside the collars starts to degrade after several years after installation.

- The vegetation condition inside the collars did not differ between the old and new plots. The vegetation in the old collars used in the present study was healthy and did not show any signs of degradation when we started our measurements in 2017.

This information was added to the article (new text in italics here):

"Eight of the 17 aluminium collars (60 cm x 60 cm) were installed during the first days of June 2017, during the soil thawing, to accompany the collars that were already *installed previously in 2006. The overall vegetation condition and species composition inside the old collars were checked to match the new study plots*."

L. 126. Did you notice the diurnal dynamic of methane emission? Can it affect any results of methane flux linear modelling?

- We checked this from the eddy covariance data, and found no systematic diurnal cycle in the methane fluxes during the period with unfrozen soil (May–October) (Figs. C1 and C2). The chamber methane flux time series were gap-filled by assuming an exponential temperature dependence, so the possible diurnal dynamic would not have affected the gap-filling.

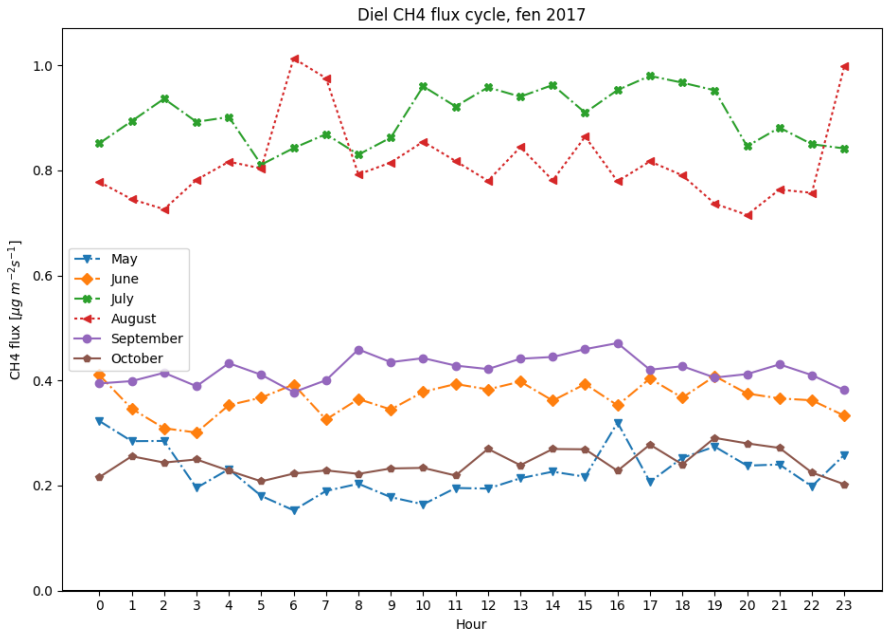

Figure C1: Monthly average diel methane flux cycle measured at the Kaamanen fen eddy covariance tower in May–October 2017.

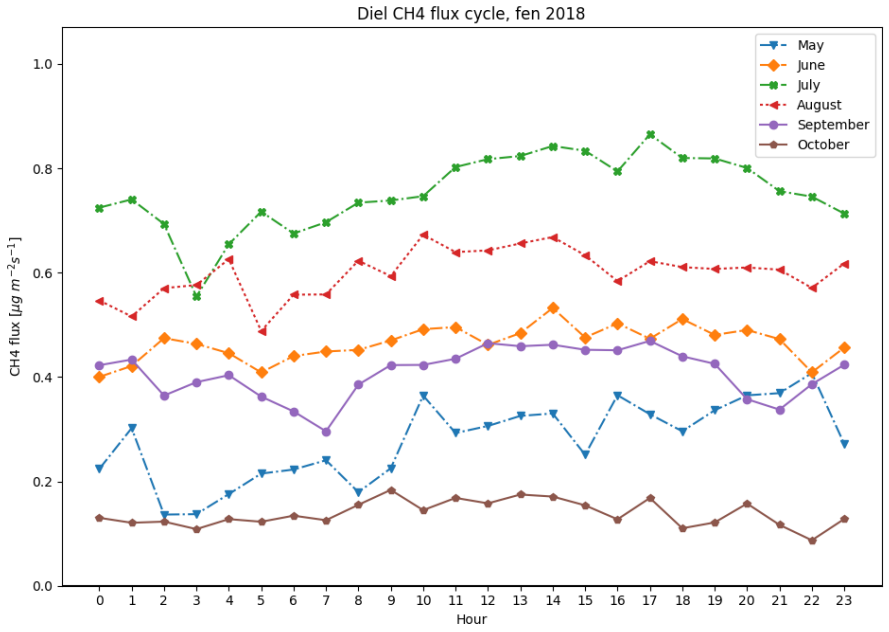

Figure C2: Monthly average diel methane flux cycle measured at the Kaamanen fen eddy covariance tower in May–October 2018.

L. 300. Please add information how much data (in % of growing season length) was gap-filled in EC fluxes of carbon dioxide and methane.

- In total, 62% (10813/17520) and 63% (11080/17520) of the 30-min EC CO_2 flux data were gap-filled in 2017 and 2018, respectively. For CH_4 flux, the corresponding proportions were 64% (11735/17520) and 70% (12208/17520).

When taking into account only the growing season period, 46% (3553/7728) and 50% (4326/8640) of the 30-min EC CO_2 flux data were gap-filled during the growing seasons 2017 and 2018, respectively. For CH4 flux, the corresponding proportions were 51% (3922/7728) and 58% (4995/8640).

This information was added to the article (Section 2.3.4 and 2.4).

L. 620. I think that you should mention that your C-balance estimate did not include dissolved and particulate carbon loss due to water flow. May be it is not that important for overall C-balance, but it is better to remind the reader about that. Probably you know papers, where information about dissolved organic carbon transport in Kaamanen fen is presented.

- We added the following note about the lateral carbon flow to Section 4.2.1:

"These balances do not include the lateral aquatic transfer of dissolved organic C and particulate C through the fen ecosystem. Aurela et al. (2002) estimated, based on Sallantaus (1994) and Kortelainen et al. (1997), that the leaching of total organic carbon was 7.5 g C m^{-2} yr^{-1}."

Aurela, M., Laurila, T. and Tuovinen, J.-P.: Annual CO2 balance of a subarctic fen in northern Europe: Importance of the wintertime efflux, Journal of Geophysical Research - Atmospheres, 107, 4607, doi:10.1029/2002JD002055, 2002.

Kortelainen, P., Saukkonen, S. and Mattson, T.: Leaching of nitrogen from forested catchments in Finland, Global Biogeochem. Cycles, 11, 627– 638, 1997.

Sallantaus, T., Response of leaching from mire ecosystems to changing climate, in The Finnish Research Programme on Climate Change, Second Progress Report, vol. 1, edited by M. Kanninen and P. Heikinheimo, pp. 291–296, Publ. Acad. Finland, Helsinki, 1994.

L. 620. Let me also ask, do you compare the methane budget for the whole Kaamanen fen based on chamber and EC data separately (using land cover map and footprint estimate)? Are they the same or there is a difference? It is important sometimes to check yourself about proper use of available methods. Potential gap between these estimates could show that we miss something important (for example ebullition in chamber flux data). It is just a recommendation of course, I understand that you have already presented enough good data.

- We understand that such an exercise would be useful and have made a preliminary effort by comparing the EC-based methane fluxes with upscaled chamber-based fluxes. This was done by upscaling the growing season chamber data to the ecosystem scale with the mapped coverage of the four main plant community types within a distance of 200 m from the EC tower (excluding the forest wind sector). This upscaling exercise did not take into account the riparian fen plant community for the chamber-based estimate; nor have we conducted a complete footprint analysis at this point.

The upscaled chamber-based CH_4 flux data matched the EC fluxes well during the growing season 2017. This was also the case for 2018 with the exception of the drought period in July. As stated in the article, the drought impact was less obvious in the plant community level fluxes than in the EC data. The discrepancy could be due to the missing riparian fen data or the uncertainty in the estimated temperature dependence in heatwave conditions. For CO_2 flux, the seasonal courses were consistent, but the chamber-based growing season balance was lower than the corresponding EC-based balance. To better understand the compatibility between the measurement techniques, a more thorough comparison involving footprint weighting of the chamber data would be needed but is beyond the scope of the present study.