Annual emissions of CH_4 and N_2O, and ecosystem respiration from eight organic soils in Western Denmark managed by agriculture

Response to Anonymous reviewer #2 *(Authors' comments are italicized)*

We would like to thank the reviewer for a positive overall evaluation of our manuscript, and for the various suggestions for improvement. Below we have given our response to each of the specific comments and described actions to be taken.

The manuscript gives a welcome and much needed comprehensive compliation on CH4 and N2O release as well as ecosystem respiration from several sites in Denmark. The manuscript is well structured and well written and Tables and Figures are of high quality. There are, however, some issues that call for clarification. I recommed acceptance of the Discussion Paper following adequate consideration of these issues.

10020, 11-12: I suggest refraining from quoting too many refereces. Two recent ones should be enough.

We will critically assess the use of quotations.

10022, 1-2: I hardly can imagine that it was impossible to find that kind of land use on peat in such a large region. Of course, it is sometimes hard to get access to all sites one would like to measure on. What means "could be found"?

We will elaborate on the background for selection of sites.

Selection of monitoring sites occurred after a number of field trips to different parts of Western Denmark to visit areas which had been selected on the basis of existing maps of organic soil. Most sites inspected were discarded for reasons such as: the peat layer had disappeared (a parallel survey of organic soils in Denmark, with >10 000 targeted soil samplings, recently documented a 40% reduction of the area with organic soil since 1975); unwillingness of the farmer to give access; and distance incompatible with logistical constraints during sampling campaigns where two measurement teams would often have to share transport. The search for suitable locations was discontinued in August, two months after the planned start of the monitoring program, where we settled for the eight locations described in the manuscript.

10022, 15: The absence of fertilization during the measurement period is a problem to the validity of your dataset. Please devote a paragraph or two in the discussions chapter on why you are sure that the absence of fertilization does not cause biased flux data. Please also give the amount of atmospheric N deposition.

N deposition for sites in the three regions will be included in a revised manuscript. Also, additional discussion of the implications of omitting N inputs during the monitoring period will be provided. Specifically, the revised manuscript will refer to literature on N_2O emissions from fertilizers and manure inputs to organic soils and discuss the potential for interactions between N inputs and soil organic N dynamics.

A main objective of the monitoring study was to provide estimates of emission factors for representative organic soils in Denmark. In the IPCC accounting system, N_2O derived from decomposition of organic matter should be distinguished from direct emissions of N_2O derived from fertilizers, manure and excretal returns (Equation 11.1; 2006 IPCC Guidelines for National GHG Inventories). Monitoring started in early autumn 2008, and thus effects of N inputs associated with *the current practice for the respective land uses were fully represented in the emissions recorded during autumn, winter and early spring. There were no amendments of manure or fertilizers in 2009, and no grazing. If such inputs had been included, then observed emissions would need to be corrected using an emission factor approach, or by a partial amendment to allow for estimation of manure/fertilizer derived N_2O emissions by difference. In either case this would need to assume that there is no interaction between fertilizer/manure and soil organic N turnover, although it is quite likely that the N status of organic soils is influenced by the annual inputs of N from various sources related to agricultural activities. Our study also suggests an interaction between groundwater dynamics and N_2O emissions for some soil types and land uses that should be further investigated.*

10023, 3-4: Where did you install the tube? At every pair of sampling points?

Yes, a piezometer tube was installed near each pair of frames, will be rephrased for clarification.

10023, 17-20: When did this happen? How did the data from the climate station fit to data from your monitoring site?

At the rotational sites continuous soil temperature and PAR data were missing during periods of soil tillage when instrumentation was removed for up to two weeks. Also, malfunction of data loggers caused a data gap during autumn 2008 for periods of one and six weeks for sites in geo-region N and E, respectively. All data gaps were filled based on data from the closest neighbouring site (within ~100 m distance). PAR data were used directly from neighbouring sites, whereas soil temperatures were derived from the air temperature at neighbouring sites and site-specific correlations between air and soil temperature.

10024, 17: Did you use transparent or dark chambers?

White PVC, as stated, hence they were ‘dark’ chambers.

Chapter 2.4: Please create a subchapter on temporal upscaling procedures and statistics. How did you calculate the annual estimates? How were error margins calculated?

A brief description was already given in Chapter 2.6.3, but we agree the information is difficult to locate. We will move the first sentence of Chapter 2.6.3. to Chapter 2.6.1 and further specify how uncertainty estimates of annual fluxes were calculated. Basically, daily fluxes were calculated by linear interpolation between sampling days for each of the three blocks (with paired sampling points) of a given site. Annual fluxes were calculated for each block by summation over the period 21 Sept 2008 to 20 Sept 2009, the standard errors representing the variation between annual estimates for each block (i.e. within-block variation on each sampling day is not included).

10030, 1st paragraph: Does this not belong to the Materials & Methods section?

We are uncertain about this question – section 2.6.4 is already part of Materials and methods.

10032, 10-11: "...which is like...": This is part of the discussion.

Agreed – will be removed from here.

10034, 5: Early spring, not spring

Agreed – will be changed.

10035, 8-13: How did you calculate the Q10? Why didn't you calculate it for CH4? Q10 is critical for the calculation of annual ecosystem respiration and it changes over time. Please give more information and discuss.

The description of the method used to calculate Q10 for each site (section 2.6.2) will be expanded. Also, we will explain better why not attempt was made to correct CH_4 fluxes.

The correction of Reco values and N_2O emissions according to soil temperature at 5 cm depth was primarily a methodological exercise to estimate the potential error due to variations in chamber deployment period on sampling days. However, we are able to assess the robustness of Reco estimates (without temperature correction) reported here because a parallel study was conducted to determine NEE of CO_2 in parallel with the present study. In the NEE study Reco was calculated on an hourly basis, rather than by simple interpolation. For most sites there was no difference in annual Reco as determined in the two monitoring programs, although samplings took place on different days, the length of deployment was different (2 vs. 60 min), the analytical method was different (LiCor IRGA vs. GC), and flux calculation method was different (MatLab script vs. HMR), which suggests that annual Reco values reported in the present study are reliable.

As stated CH_4 fluxes were generally low, and any estimation of Q10 would therefore in any case be highly uncertain. Also, CH_4 fluxes depend on CH_4 production in saturated parts of the soil profile, and CH_4 oxidation may also occur at depth in the soil, near the groundwater table (Hornibrook et al., 2009; Biogeosciences, 6, 1491–1504). Selecting an appropriate temperature for correction would be difficult, but also daily temperature variations, and hence the error associated with sampling time, would be relatively small at depth in the soil.

10040, 25: Check spelling of the authors name.

OK

10041, 1: Preferential gas exchange via aerenchyma is also an issue when peat structure is intact.

A follow-up study of methane fluxes from three grasslands on peat was conducted in 2010-2011. It included existing and new sampling points at site E-PG, as well as two new locations, At each site four paired sampling points were selected, one with a tussock of J. effusus, the other with grass only. Only at site E-PG was a contribution of Juncus to methane emissions consistently seen, and in general the importance of Juncus was relatively much smaller than seasonal dynamics related to soil moisture and groundwater table. Hence, at present we would like to maintain that in drained grasslands on peat the importance of Juncus will very much depend on soil conditions in a m-scale.

References: Lloyd & Taylor is missing, Maljanen et al is given before Madsen ==> Check References section again.

OK – will do.

Table 1: Give geographical coordinates of the sites and a map of Denmark showing the sites and the three regions.

OK – will be included.