MS no.: bg–2009–182 Novak et al. C cycling in transplanted peat
Responses to the reviewers' comments

We wish to extend a sincere thank you to both reviewers, and the Editor. Their careful and insightful reviews/comments have resulted in a much improved manuscript which will be of greater use to the scientific community.

Major amendments include: New data on bog pore water chemistry, detailed lists of *Sphagnum* species at the study sites, new data on concentrations and carbon isotope compositions of carbon dioxide and methane emitted from the peat bogs in their natural seetings. We also visualize the comparison of our (relatively high) C accumulation rates at VJJ and CB with other sites by including a new Figure in the Electronic Annex. We have added text on topics suggested by both reviewers in the Discussion section and added new references to recent work relevant to our study.

Reviewer no. 1

General comments:

"Available studies are not well incorporated in the introduction." – Our response: Five references have been added to the Introduction.

"Available studies are not well incorporated in the Discussion" – 10 new references have been incorporated in the Discussion. All points raised by the reviewer in the context of missing references are part of the new version of the paper.

"Introduce the different methanogenic pathways early in the manuscript." – Done.

"Cite more work on the isotopic composition of CO_2 and methane, your differences are relatively small compared to the literature." – References added. The range of isotope values of C-containing gases in this study is compared with the literature.

"Introduce more literature on transplant experiments." – Done.

"Leave out 1 or two self-references, inlude work from other groups and sites." – Done. There was a wordier earlier version of the manuscript, but before submission we cut the length and deleted also quite a few references, which are now back. Thank you, and apologies for the wrong impression we may have left.

"Link the data better to existing data." – Done. (Clearly, this can be done using an almost endless list of published studies covering various aspects of wetland C cycling. Thus we choose discussing our data mainly in light of a very insightful recent study by Clymo & Bryan, Geochim. Cosmochim. Acta 2008.)

Specific comments:

"Abstract: Do not mix methane production and methane emission." – The two terms are now separated, two different meanings are stressed.

"Comment on literature reporting Pb mobility in peat." –Thank you for this suggestion. We spent several years working in this field, and gathered evidence that buried atmogenic Pb is largely immobile in vertical peat profiles. For example, we performed the first replicated experimental laboratory study in which Pb was added to the surface of peat cores, and the cores were wetted for a long period of time in order to quantify vertical Pb mobility in peat (Vile MA, Wieder RK & Novak M. 1999. Mobility of Pb in *Sphagnum*-derived peat. Biogeochemistry 45, 35-52). We also corroborated Pb dates with pollen analysis in three papers (Vile MA, Novak M, Brizova E, Wieder RK, Schell W.R. 1995. Historical rates of atmospheric Pb deposition using ^{210}Pb-dated peat cores: Corroboration, computation and interpretation. Water Air Soil Pollut 79, 89-106; Wieder RK, Novak M, Schell WR, Rhodes T. 1994. Rates of peat accumulation over the past 200 years in five *Sphagnum*-dominated peatlands in the United States. J Paleolimnol 12, 35-47; Novak M, Brizova E, Adamova M, Erbanova L, Bottrell SH. 2008. Accumulation of organic carbon over the past 150 years in five freshwater peatlands in western and central Europe. Sci Total Environ 390, 426-436). Additionally, at a number of European sites we found that non-geochemical archived industrial output data on lead agree with the vertical record in peat, using also stable Pb isotope ratios (Novak et al. 2003 Environ Sci Technol 37, 437-445; Novak et al. 2008 Atmos Environ 42, 8997-9006). In the new version, we do not cite *all* our previous work on the topic (elsewhere we promised to reduce the number of self-references). We do include also two references questioning Pb immobility in peat.

"Page 9: There is an important study on global CH_4 sources by Fletcher et al. 2004." – Reference and text included.

"Include literature on the isotope mass balancing." – Done. Especially impressive for us is the Biogeosciences 2008 Knorr, Glaser, Blodau paper.

"The isotope mass balance idea is good but needs to be linked to the transplant study." – We have added a new paragraph.

"Do you have shifts when looking at the different treatments?" – Yes, we are comparing a transplant experiment with a control in Fig. 6.

"The transplant experiment is also an interesting tool to study the impact of sulfur and other site-specific environmental factors on methanogenesis." – This also is seen in Fig. 6. Discussion amended.

"Page 14, line 22: I got lost in this construction." – Rephrased, simplified.

"CB to CB had the lowest gas production, VJJ to VJJ had the highest gas production. Discuss later on." – Done.

"Maybe the disturbance effect of coring had a different impact on the two peats?" – We do not think it did. The mass of peat inside the column unaffected by the incision is much larger than the mass of the peat directly adjacent to the incision. The incision is more of a problem in well aerated forest soils which you incubate in the laboratory and wet by artificial precipitation. Then the soil surface in contact with the cover cylinder tends to be a pathway of preferential penetration of water to greater depths.

However, in those experiments you are usually not interested in emanating gases, but rather in biogeochemical cycling of liquid species. *Cf.*, *e.g.*, Novak et al. 2001 Environ. Sci Technol 35, 225-260, where we studied penetration of a ^{34}S isotope label into forest soil. With respect to our present peat study, we found no differences in making incisions into CB and into VJJ peat upon visual inspection. Over 80 % of themass of wet peat in this experiment was represented by brown water which easily flows through the porous upper layers of the organic soil. Addid an incision does not enhance free horizontal water trajectories.

"Avoid striking feature." – Done.

"C used for methanogenesis and other respiratory pathways is younger than the surrounding C, methanogenic activity is related to photosynthetic activity. Can possibly DOC entering our cores from aside plus freshly formed plant exudates be responsible for the convergence? Add reference to Chasar, Crow and Wieder, Fenner et al." – References added. Discussion amended. The unanswered question remains how could possibly more young DOC and plant exudates in the incisions at CB cause less gas production at this site?

"Why do you think samples producing more CO_2 and methane at their home location (VJJ) had isotopically lighter carbon? More methane production would make me expect more loss of light isotopes. A question of organic matter quality? Pathway/microbial community?" – Present-day methane production may mean more loss of light isotopes for the substrate. But there is so much solid substrate compared to the evolving methane, that we cannot see the change in the substrate.

"slow - typo" – Corrected.

"Page 17: High availability of nutrients at VJJ may have contributed... Give a reference. Aerts et al. 2003 did not find an impact of nutrient addition on litter decomposition rates." – The newly added Table 3 illustrates that higher nutritional status of VJJ is not a speculation, we do have water chemistry data, which are now presented. Beyond that, we have added the suggested reference and modified the text.

"Add Hornibrook for more del^{13}C profiles in peat." – Done.

"Introduce different pathways of methanogenesis, introduce methanotropy. There is more literature on the residual isotope enrichment issue." – Done.

"How much are these changes in CO_2 isotopic signature compared to observed ranges of soil methane and CO_2?" – Info added.

"There is literature on del^{13}C of plants under different climatic conditions. Add one reference." – Done.

"Increase of del^{13}C in substrate downcore. Make again a link to methanogenesis." – Done.

"Some explanations are ruled out. I see only vascular plants." – Rephrased.

"Elaborate on DOC, young carbon from plants, soil solution chemistry as environmental parameters." - Done.

"I suppose the exchange of soil solutions was not hindered in this experimental design." – Correct, the peat cores were wrapped in a mesh.

Reviewer no. 2

General comments:

"The manuscript would benefit from more thorough discussion." – Done, please see specific comments.

"Add data on nutrient status." – Done, a new Table 3 added.

"Add data on *Sphagnum* species." – Done, a new Table 2 added.

"Add references by other authors, reduce self-referencing." – Done.

Specific comments:

"What *Sphagnum* species?" – Please see Table 2.

"There are a couple of publications stressing that *Sphagnum* growth rates differ between species. This might help to explain differences at your sites." – References and text added.

"Following an extended period of exposition to nutrients, *Sphagnum* species distribution might change." – True, in the new version we make this point. However, within our transplanted peat cores the native *Sphagnum* did not die in a single replicate.

"Why did you choose such a short incubation time? I would have continued measuring CO_2 and CH_4 release." – Based on the literature we knew that the emission of CO_2 would be almost linear, and therefore even two measurements in time may do. In case of methane, we knew from the literature, that it may behave quite unpredictably, and that it will be partly consumed soon after the start of the incubation.

"The abstract does not close with a take home mesage." – Thank you. Text amended.

"Discuss your high present peat accummulation rates with other studies." – Done.

"Chapter 4.3. Could DOC in pore water be an important source of labile C? Maybe porewater is the main control of CO_2 and methane emissions? Discuss and add more publications." – Done. In the new version we stress DOC as a source of labile C for imcrobial processes. We also poit out that DOC production decreases with increasing peat depth.

"Are there any field measurements of methane and CO_2 release at your sites? Please add a few references." – Snapshot data added.

"Any data on nutrients in peat pore water?" – Yes, please see the new Table 3 and new discussion.

"Diagenesis" typo corrected.

Editor's coments:

"How were fluxes calculated from dC/dT from Figs A1-A4? The concentration changes were not linear." - Details added to methods. Statistical models were applied.

"Why were not home cores analyzed from the end of the experiment as were the transplanted cores? This 18 month delay might theoretically introduce a bias into the comparison." – The isotope data set for this paper is huge, compared to the average C isotope paper about organic soils in high ranking journals (for soild substrate alone we present two hundred del^{13}C values, plus isotope data for CO_2 and methane). The cost was an insurmountable obstacle, and we expected more differences in the gases then in the substrate. Basically, the dilemma was do we analyze the true time zero natural conditions or do we skip that and include the possible incision artifact into the control? From another long peat transplant used by M. Vile for the PhD thesis at Univ. of Notre Dame (sulfur isotopes) we analyzed the re-inserted controls at the end and the unianimous opinion of the panel was that real natural conditions at time zero are a better choice, given finacial constraints.

"Remove toward the end..." – Done.

"Why include S and N throughfall data if both bogs were at open sites?" – The research plots were at open sites, while large segments of the bogs were forested. The distance of the forest may have been tens to hundreds of meters from the coring place, but there is always a strong lateral flow of the surface bog water (reaching to a very shallow depth only, though), so atmospheric deposition gets mixed throroughly and rapidly.

"Fig. 3: Remove mean and std. error from figure legend." – Thank you. Done.

"Fig. 4: I would show CB and CB to VJJ in one panel... " – We believe that the existing representation is reader friendlier (during the one whole year of improving this manuscript whe have tried all combinations of possible graphs). We are adding your suggested representation into the Electronic Annex (A5) so that the reader has a choice of looking at alternative representations of the data.

"Why are there no data available below 30 cm from the transplanted cores - add to methods." – We were surpised to see there were fewer 2 cm sections of the frozen cores than expected. We can only speculate that the 2.5 mm mesh during peat handling lets out some of the fine grained matured peat from greater depths - when you reinsert your cores there is plenty of water around, a lot of water is dripping off the extruded monoliths, and at a depth of 30 cm you do not have undecayed roots to

hold the disintegrated substrate firmly together. A sentence added to the methods. We believe that this artifact did not seriously affect experimental results. We note that upon visual inspection in month 18, the surface of the transplanted peat cores was not in microtopographic depressions. In other words, compaction due to lower density of bottom peat was not visible. Thank you for pointing this out, the phenomenon may merit a further methodological study.

Figs. A1-4: I would use symbols rather than bars, show the calculated flux." – Done.

"Fig. 5: same as Fig. 4." – Our response: The current Fig. 5 already has CB and CB to VJJ in the left panel, as suggested above by the reviewer for Fig. 4.