

Interactive comment on “Methanotrophy potential versus methane supply by pore water diffusion in peatlands” by E. R. C. Hornibrook et al.

E. R. C. Hornibrook et al.

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We thank the referee for their review and constructive suggestions for improvement of our manuscript. Revisions made to the manuscript in response to reviewer’s comments are described below. We provide explanations for instances where we do not concur with recommended changes.

Anonymous Referee #2 (Received and published: 4 August 2008) 1. Page 2609, lines 5-7, 16-27: In acidic peat there also are methane oxidizers others than Types I and II (they do not have soluble methane monooxygenase, e.g. AEM 64: 922-929, 1998). However, here the text on the diversity could be shortened because methane oxidation is not linked to the diversity of methane oxidizers.

Response: Whether a link between methanotroph diversity and CH₄ oxidation (rates?)

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has been established is not essential for inclusion of this short summary of efforts to date to characterize microorganisms responsible for methanotrophy in anoxic soils. The information contained in these dozen or so lines is not excessive and has been retained.

2. There are rather many figures in the manuscript, some could be excluded. These include Fig. 1. There are several figures (Figs 3, 4, 5 and 6) for dissolved methane in pore water profiles. Only one typical profile would be shown, and the rest can be excluded.

Response: The pore water profiles in Figs. 3, 4, 5 and 6 are the central aspect of this manuscript around which much of the analysis and discussion are based. The data are not presented elsewhere in the manuscript in table format and in our opinion, it is important that the data be shown explicitly given some of the issues raised by other reviewers (e.g., the basis for regression analysis of pore water [CH₄] data, the depth of the 3 cm thick zone in which CH₄ oxidation rates were integrated, etc.). The figures have been retained.

3. The information in the Table 4 can be shown in the legend of the Fig. 7.

Response: The 8 regression equations in Table 4 are presented in a clear manner. Incorporating the equations into the caption of Fig. 7 (which is already a lengthy caption) would diminish the clarity of presentation. Table 4 has not been deleted.

4. Page 2628, lines 24-26: In a short-term this conclusion would be true but if methane oxidation is totally lacking the methane concentration in the peat profile increases causing higher methane release via vascular plants and bubbling. This text should be revised by considering this comment.

Response: We agree that the sentence is ambiguous. We have removed the following text: [however, in the absence of bacterial CH₄ oxidation the flux rate from minerotrophic peatlands would not be significantly greater.]

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5. Some comments could be added why the kinetic parameters were larger in the ombrotrophic than minerotrophic peatlands although methane production is expected to be higher in the later peatland types? Is the reason lack of methane and oxygen transport by vascular plants in the ombrotrophic peat? Was the methane concentration higher in the ombrotrophic peat profiles?

Response: It is unclear why the kinetic parameters (μ_m and K_s) were greater in Cors Caron than Crymlyn Bog. Given that these data are available for only two peatlands we are wary of over-interpreting the results at this stage. Methanotrophs in the ombrotrophic peat may exist in situ under more O₂-limited conditions than those within the minerotrophic site. Pore water CH₄ concentrations typically were greater in the minerotrophic peatlands (Figs. 3 (Crymlyn Bog) & 4 (Gors Lwyd) versus Figs. 5 (Blaen Ffynnon) and 6 (Cors Caron), consistent with higher CH₄ production rates measured in vitro for those peatlands (data reported in Hornibrook & Bowes, 2007).

6. It would be interesting if the coverage of various vascular plant species are correlated with the surface methane fluxes. Then their importance in the methane transport is shown here, and some other explanations for the high emissions (like bubbling) can be excluded.

Response: High CH₄ emission rates due to ebullition appear as sudden increases in CH₄ concentration within the closed flux chambers. As discussed in responses to Comment 14 by Reviewer 3 and Comment 2 by Reviewer 4, ebullition fluxes have been removed from the data sets (primarily for Gors Lwyd). The high fluxes that remain must be due to plant-mediated transport because pore water diffusion rates are too low to cause the observed CH₄ emission rates. This aspect of CH₄ export from peatlands has been well studied in the past (e.g., Chanton & Dacey, 1991; Schütz et al., 1991; Morrissey et al., 1993; Bubier, 1995; Sugimoto & Fujita, 1997; King et al., 1998; Joabsson et al., 1999; Segers & Leffelaar, 2001; Kettunen, 2003). Additional information about dominant vegetation types at each peatland have been added to Table 1 (as requested by Reviewers 3 & 4); however, we do not have detailed plant surveys for the

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study sites or sufficient coverage of flux measurements to quantify how differences in vegetation coverage contributed to CH₄ flux rates in these four peatland. The issue is likely to be more complex than just differences in plant coverage. For example, potential CH₄ production rates for the four peatlands published in Hornibrook & Bowes (2007) demonstrate that the minerotrophic peatlands (Gors Lwyd and Crymlyn Bog) have the capacity to generate greater quantities of CH₄ than the ombrotrophic peatlands (Cors Caron and Blaen Fyn). In summary, we are confident that ebullition can be discounted as a source of the high CH₄ flux rates because (i) flux chamber data exhibiting steps in CH₄ concentration are not included in the data shown in Table 3, and (ii) d¹³C values of CH₄ pore water and flux reported by Hornibrook & Bowes (2007) for these peatlands indicate that plant-mediated transport is the dominant process exporting CH₄ from peat soils to the atmosphere in all four sites.

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7. Is there evidence that methane released from ombrotrophic peatlands is more ^{13}C -enriched than methane from minerotrophic peatlands?

Response: Methane emitted from the ombrotrophic peatlands is ^{13}C -depleted relative to the minerotrophic sites because of a predominance of H_2/CO_2 methanogenesis in the acidic mires which yields CH_4 having negative d^{13}C values relative to CH_4 produced by acetate fermentation in the more alkaline peat soils. Plant-mediated transport imparts an additional negative shift in $\text{d}^{13}\text{C}(\text{CH}_4)$ values of ~ 12 to 20 permil in all four peatlands (Hornibrook & Bowes, 2007).

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