

## ***Interactive comment on “Stable carbon isotope fractionation during methanogenesis in three boreal peatland ecosystems” by P. E. Galand et al.***

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We are grateful to the positive and constructive comments of two anonymous reviewers, which we answer as follows:

### **Referee #1:**

1) We indeed observed the highest acetate concentrations in the peat of the mesotrophic fen, and also observed there the largest accumulation of acetate in the presence of methyl fluoride. These observations are consistent with higher rates of organic matter degradation at the mesotrophic site versus the oligotrophic ones, also seen by the larger production rates of  $\text{CH}_4$  and  $\text{CO}_2$ . It is true that acetate accumulation has been observed in some oligotrophic bogs, but only if they were devoid of

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populations of acetoclastic methanogens (e.g., Hines et al., 2008). However, if oligotrophic bogs did contain acetoclastic methanogens (e.g. Kotsyurbenko et al. 2004), then acetate concentrations were also low. Compare point (1) of referee #2.

In principle, in-situ acetate concentration ( $C$ ) is a function of acetate production rate ( $p$ ) and acetate consumption rate ( $k$ ). It is reasonable to assume that consumption is a first order reaction with respect to acetate, so that in steady state  $p = k C$ , or  $C = p/k$ . Depending on the magnitude of  $p$  and  $k$ ,  $C$  might actually take on any possible value depending on environmental conditions affecting  $P$  and  $k$ .

2) The referee correctly observed that the rates of  $\text{CH}_4$  production reported in our manuscript were much higher than those reported by Juottonen et al. (2005) for the same site. The referee suggests that the reason may be due to the release of labile material during coring and the preparation of incubation vessels. We agree that this is well possible, in particular since our samples were taken in August, whereas those by Juottonen et al. (2005) were taken in October. The higher rates in August may not only be caused by the different season, but in particular by the fact that plant growth involving the mobilization of labile organic matter is more pronounced in summer than in fall, when plants are no longer active. We added a comment to the Discussion on p. 9.

3) All of our sites exhibited a mixture of hydrogenotrophic and acetoclastic methanogenesis. However, we pointed out that while the mesotrophic site exhibited the two types of methanogenesis close to the theoretically (assuming complete degradation of polysaccharides) expected ratio of 1:2, the oligotrophic sites had much higher ratios. It is true that at some reports showed methanogenesis exclusively from  $\text{H}_2/\text{CO}_2$ . However, at these sites acetoclastic methanogens were absent and acetate accumulated even in the absence of inhibitor (compare point (1) above). In most aquatic sediments, however, acetate is low and accumulates only if its consumption is inhibited. We added a comment to the Discussion on p. 13.

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**Referee #2:**

1) The first comment of the referee is basically the same as that by referee #1, answered above in point (1). We would like to point out that acetate has been consumed in the peat of all three sites, which is seen by the effect of methyl fluoride resulting in at least a little acetate accumulation and by the calculation of the fraction of CH<sub>4</sub> produced from H<sub>2</sub>/CO<sub>2</sub>, which is high in the two oligotrophic sites but not 100% (the remainder being due to CH<sub>4</sub> formation from acetate).

2) The second comment concerns the terminology. In Scandinavia the term “bog” has mainly been reserved for ombrotrophic mire communities, ombrotrophic meaning that water and nutrients are supplied by precipitation and not by ground flow. Mires with ground flow are termed “fens”. Ombrotrophic bogs are by definition oligotrophic. Fens can be both oligotrophic or mesotrophic. For clarity, we replaced “ombrotrophic bog” by “oligotrophic ombrotrophic bog” on p.4, L.7.

3) The referee asks for some more description about the sites. The full description of the sites is found in Juottonen et al. (2005). Briefly, MES is a mesotrophic fen, the vegetation of which is a mosaic of lawn and minerotrophic hollow level communities with high diversity. The field layer in both communities is characterized by sedges (*Carex rostrata*, *C. lasiocarpa*) and some herbaceous species, such as *Potentilla palustris* and *Menyanthes trifoliata*. In the drier lawn surfaces, the bottom layer is dominated by *Sphagnum* mosses (*S. fallax*, *S. flexuosum*, *S. magellanicum*), whereas in wetter hollow surfaces *Sphagnum subsecundum* is found together with *Warnstorfia exannulata* and *Utricularia intermedia*. Study site OLI is an oligotrophic fen, which consists of a fairly homogenous lawn level vegetation, dominated by *C. lasiocarpa* with some *Betula nana* in the field layer, and *Sphagnum papillosum*, *S. fallax* and *S. flexuosum* in the moss layer. Water table in both fen sites MES and OLI is near the surface and has small spatial and seasonal variation. Site OMB is an ombrotrophic bog. It is a mosaic of ecohydrological gradients shown as changing plant communities from wet hollows to intermediate lawns and finally to drier hummock communities. In addition to

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spatial variation, water level has large seasonal variations. *Eriophorum vaginatum*, together with *Andromeda polifolia* and *Rubus chamaemorus*, is the most abundant field layer species; *Sphagnum cuspidatum* dominates in the bottom layer of the hollows, *S. balticum* in the lawns and *S. fuscum* in the hummocks. We included this brief description on p.4, L.4.

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