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Interactive comment on "Spatial variability of diploptene δ^{13}C values in thermokarst lakes: the potential to analyse the complexity of lacustrine methane cycling" *by* K. L. Davies et al.

Anonymous Referee #1

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This is a manuscript which suggests a potential method for reconstructing past CH4 cycling and dynamics in northern lakes "from sedimentary archives", in this case, from δ13C measurements of the bacterial biomarker diploptene.

However, the data show that even within a single lake, there are huge variations on δ13C-diploptene. So the manuscript has, to my mind, rather a null result–the manuscript is basically a report of new data. The title of the manuscript makes me think there is potential for using δ13C on diploptene for reconstructing historical estimates of lake methane ebullition...but after reading the manuscript, I am not so sure that is true. Perhaps, as the authors suggest, more data would help the situation.

This is not to say that this is a bad manuscript. Sometimes results are not as concrete as we expect. However, the authors should be careful to not suggest that the proposed method appears more valuable than it really is (at least at our current state of knowledge). Specifically, I think the abstract is more positive about using δ13C-diploptene observations for reconstructing past methane oxidation in lakes than the manuscript supports.

The authors suggest numerous reasons for the differences in their δ13C-diploptene observations (different areas of the lakes, etc.) but considering that this study of only two lakes shows that similar thermokarst-influenced areas of the two lakes have very different δ13C-diploptene values, it is hard to see what this tells us on a wider perspective.

I think this manuscript can be published, as long as the authors are clear that this is a very preliminary study, which basically tells us that with more research, δ13C-diploptene might become useful as a biomarker for informing methane oxidation history in lake sediments. But for now, we don't know enough to reliably apply it.

::MAJOR COMMENTS::

(1) Diploptene is mispelled TWICE in the abstract. "Diplotene" is something completely different (and is not a chemical).

(2) -in the abstract: "Using δ13C-diploptene as a proxy for methane oxidation activity, we suggest the observed differences in methane oxidation levels among sites within the two lakes could be linked to differences in source area of methane production (e.g. age and type of organic carbon) and bathymetry as it relates to varying oxycline depths and changing pressure gradients."

Ok...but as noted in the manuscript, there was no radiocarbon dating in one of the lakes. So it seems that the suggestion of age differences is premature.

(3) Section 5.3: "A crucial outcome of this study is the large variability seen in the δ13C

values of diploptene across small spatial distances. This is an important finding, as often whole lakes can be represented by a single sampling site in palaeoenvironmental studies."

I agree with this! But it undermines some of the conclusions of the manuscript, especially the last statement of the conclusions: "We conclude that diploptene biomarkers have considerable potential to help reconstruct patterns of methane cycling in lakes and, with certain caveats, particularly attention to context, past methane dynamics."

Isn't it more true that this study raises MANY cautions that must be resolved before δ13C-diploptene values can be used to "reconstruct patterns of methane cycling and past methane dynamics"?

I don't see how the results in this study do much more than show that sometimes the δ13C-diploptene values make sense with current observations of methane ebullition and methane oxidizing bacteria biomass, and sometimes they don't (e.g. Figure 4).

::SMALL COMMENTS::

page 12159: "The connections between methane production..." This sentence should be split into two sentences, probably after "not well understood"

"We assessed methane oxidation as represented by methane oxidation..." "(as represented by methane oxidising bacteria)" should be parenthetical, Or rebuild the sentence.

page 12164: "in the food web to the incorporation of carbon from of methane" extra word: remove "of"

page 12166: odd to cite personal observation from the first author.

"actively thermokarsting" Don't verb nouns unless absolutely necessary.

page 12171: It's too bad that there is no radiocarbon data for Ace Lake.

page 12176: "palaeoenvironmental investigations take into lake type" should be "palaeoenvironmental investigations take into account lake type"

::FIGURES::

Figure 2: unit "Mg" should be "mg"

Figure 3: What is the basis of the bin sizes for the bubble counts on this figure?

The first interval has size 3, then a bin size of 6, then a bin size of 5, then a bin size of 2, then a bin size of 93! Why?

Figures 3 and 4: The compass rose arrow is WRONG on one of these figures. I don't know which is wrong, but they both cannot be true.

Also, the shoreline of Ace Lake looks rather different in Figure 3 and Figure 4. Why?

Interactive comment on Biogeosciences Discuss., 12, 12157, 2015.