

General comments: The authors present an interesting study of the variability of the isotopic composition and geochemistry in kettle lakes due to the future variability of recharge and climate. In this aim, the authors compare the measured $\delta^{18}\text{O}$ and $\delta^2\text{H}$ in several kettle lakes at annual and monthly intervals and the modeled $\delta^{18}\text{O}$ and $\delta^2\text{H}$. The modeled isotopic composition of lake is estimated from climate and estimation recharge models. The modeling results are used to determine if the future evolution of the climate and the recharge could modify the isotopic signature of lake and if the isotopic monitoring in lakes could be an efficient tool to highlights the variability of water budget and quality.

The modeling results have be well analyzed and interpreted, and the authors explain well the assumptions and the limits of their results. The authors study also the water quality but only by the phosphorous. This part, for me, is not really on the topic of this article, less argue than the part about isotopic signature, and maybe not necessary.

Specific comments: The paper is relatively clear, well written, well structured. Nevertheless, some parts are too long and descriptive and has to modify for a better understanding, notably in the part of results and discussion.

We thank Reviewer 2 very much for considering this manuscript, and for all of the helpful comments. Please find our responses to Reviewer 2's comments below.

Abstract: The abstract is completed and structured, nevertheless the scientific problematic is not really highlighted, could you add a sentence explaining more clearly the problematic of the paper.

Thanks to the Reviewer 2 for this comment, a sentence has been added in the abstract.

Introduction: Line: 86-88: the interest of this sentence and the link with the end of this paragraph is not clear. Please modify this sentence. The study is based on kettle lakes, this methodological choice should be exposed in the introduction.

Thanks to the Reviewer 2 for this comment, the sentence has been modified and a sentence has been added about kettle lakes.

Methods: Line 187-190 : the sentence is not clear; please modify it.

The sentence has been modified.

Water mass balance: several assumptions ($I_s=0$, $I_r=0$) has not justified, could you please add a sentence to justify this hypothesis.

The chosen kettle lakes do not have any surface stream inflow that is why $I_s=0$. Moreover they are set in fluvioglacial deposits, therefore overland flow to lakes in the study areas is considered to be low because of the permeable nature of the sandy soils. Moreover, in such a particularly cold continental climate, runoff occurs mainly during the snow melt period as well as groundwater recharge. In previous study on Lacasse lake, we have seen that runoff is negligible face to precipitation and groundwater inflows (Arnoux et al. 2017b). Moreover, considering that runoff to kettle lakes is negligible has been used by other authors in such similar climatic contexts (see Isokangas et al 2015; Krabbenhoft et al 1990). However we agree with the reviewer that it has to be notified in the text and keep in mind in the assumption of the model. Sentences have been added in the method part and in the conclusion for this assumption.

Line 251-254: this sentence is not clear; please modify it.

The sentence has been modified.

Paragraph evolution scenarios: an introductive sentence could allow a better understanding of this paragraph reminding the interest and using of these models in the study.

Sentences have been added.

Line 296-297: Please explain the interest to work with two period, a reference period and future period. Indeed, the reference period is largely in the future. Please explain moreover the choice of 2040 for the transition between these two periods.

This choice has been made because of recharge predictions from Rivards et al. 2014 which are on a reference period, based on actual measurement, and a future 2041-2070 period, therefore to use these data it was necessary to work on a reference period close to present and on 2041-2070 for future period. Also, the reference period has been chosen to cross the two years 2015-2016 field campaign in order to calibrate the model. Furthermore, we decided to choose the same time duration for these two compared periods (to have same signification on means) and the same model for climate data (for the consistency of modelling), that is why we use the 2010-2040 period as the reference period.

Figure 2: what represent the dotted line? The dotted line is just a mark to facilitate the reading.

Fig. 3: It's difficult to understand which model is used, could you clarified this in the caption. In the text, we can suppose that the fig.3a is a result of the publication Arnoux et al., 2017b, if it is the case, could you add the citation in the caption? The Figure 3 caption has been clarified.

Results and discussion: Monthly evolution of lake isotopic composition

Line 373: please, remind quickly how the G-index is measured.

It has been added to the text.

Fig. 4: the interest of the close-up is relatively low, without its, the figure will be clearer.

We agree with the reviewer, however, we decided to keep this representation to show to the reader the range of variations of our results and on what are based the means.

Fig. 5, line 389-393: the link between the figure and the interpretation is not clear. We talk about on one hand of reference period on the other hand of the future period while in the figure, the difference between reference period and future period is illustrated.

As the reference period is the same for all future scenarios (S0, S1, S2 and NC), difference between reference and future with changes ($\Delta\delta^{18}\text{O}$ S0, S1 and S2) can be compared to difference between reference and future with no change ($\Delta\delta^{18}\text{O}$ NC) which is equivalent to a comparison scenarios regarding no change in future. But as suggested by the reviewer, the text has been modified to be clearer.

Annual isotopic signature evolution, isotopic signature evolution.

This paragraph is not clear. Indeed, first, line 456-458 the authors explains that lakes with a low G-index and a small volume have higher potential variability in isotopic composition than those with a high G-index and high volume but to illustrate the remark, they used two lakes with a similar mean G-index. Secondly, line 463 to 464, the authors write that “when lakes have a high G-index, the groundwater flux tends to buffer lake isotopic variations, and so they tend to be less sensitive to changes in climate data”, but the authors don't give some arguments (results or figure). Please, be clearer. Furthermore, this sentence is not consistent with the figure 8, and the explanation line 476 to 477 “lake isotopic composition is more sensitive to changes in recharge for G-indices ranging from 50 to 80%, with a maximum of sensitivity observed for a G-index of around 65 %”. Please clarified this paragraph.

Thanks to the reviewer 2 for this comment, this paragraph has been clarified: lakes with a low G-index and a small volume have higher potential variability in isotopic composition regarding climate variability (evaporation and precipitation) while lake with G-indices ranging from 50 to 80% have an isotopic composition more sensitive to changes in recharge. We explain first the variability regarding climatic parameters and then, regarding changes in recharge.

Lake quality evolution

This part of the article is disconnected of the other results, where the isotopic variability is analyzed. The scientific interest of the part about the P is really lesser than the rest of the article and not necessary.

We agree with the Reviewer 2 that this part is more qualitative than the rest of the paper but we decided to keep it in the paper because how recharge changes can influence P load to lakes is not often taking into account in model studies and we think that it can be an important aspect to be considered. That is why in this paper, where we talk about how lake geochemistry can change in the future regarding recharge changes, we propose a first estimation of how P load to lake could be affected by recharge change. It is a first step for a more complex model, based on P dynamics in lakes, to determine more precisely how lake will be affected by P load changes in future. Some sentences have been added in this part to better make the link with the rest of the paper.

Conclusion: This part is clear and well structured. Just, please highlight that when you talk about water quality you study only the evolution of P. Moreover, the sentence, line 573-575, underlines that the part about P is based on several assumptions (not exposed in the article) and that this part is maybe not necessary on this article.

The assumptions about lake quality evolution have been added in the lake quality evolution part.

Technical corrections:

Line 188 : two weeks

Line 205: avoid that the (δp) is not at the same line that precipitation.

Line 211: the equation is in subscript.

Line 263: two time-levels

Line 333: add parenthesis for Rivard et al., 2014, same line 343.

Line 364: check the English

Figure 6: be careful the indicated period is different between the text and the caption.

Line 462: be careful for the reading of the lake volume.

Same line 466

Thanks to the reviewer, the technical corrections have been done.

References

- Arnoux, M., Barbecot, F., Gibert-Brunet, E., Gibson, J., Rosa, E., and Noret, A., Monvoisin, G.: Geochemical and isotopic mass balances of kettle lakes in southern Quebec (Canada) as tools to document variations in groundwater quantity and quality, *Environmental Earth Sciences*, 76 (3), 106. DOI: 10.1007/s12665-017-6410-6, 2017a.
- Arnoux, M., Gibert-Brunet, E., Barbecot, F., Gillon, S., Gibson, J., and Noret, A.: Seasonal ice-cover lakes and groundwater interactions: using water stable isotope and radon-222 multi-layer mass balance models (Quebec), *Hydrological processes*, 2017b.
- Isokangas, E., Rozanski, K., Rossi, P. M., Ronkanen, A. K., and Kløve, B.: Quantifying groundwater dependence of a sub-polar lake cluster in Finland using an isotope mass balance approach, *Hydrology and Earth System Sciences*, 19, 1247-1262, 10.5194/hess-19-1247-2015, 2015.
- Krabbenhoft, D. P., Bowser, C. J., Anderson, M. P., and Valley, J. W.: ESTIMATING GROUNDWATER EXCHANGE WITH LAKES .1. THE STABLE ISOTOPE MASS BALANCE METHOD, *Water Resources Research*, 26, 2445-2453, 10.1029/90wr01135, 1990.