Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2020-441-AC1, 2021

Biogeosciences Discussions

Interactive comment on "Modern silicon dynamics of a small high-latitude subarctic lake" *by* Petra Zahajská et al.

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Received and published: 12 February 2021

We thank Referee 1 for suggested edits and clarifications. We followed these suggestions carefully for the revision. We enclose a full account of our responses (normal font) to the comments and suggestions of the reviewer (in italics), including references to all changes in the manuscript.

The manuscript by Zahajská et al provides insights into the silicon dynamics of a small subarctic lake in Sweden. Through this, the authors demonstrate the considerable importance of groundwater in lake silicon cycling in order to account for the changes in their monitoring record. Whilst the amount of raw data in the paper is relatively low, the findings will be of considerable interest to biogeochemists in future silicon cycling

studies (both those working on both large/small as well as high/low latitude lakes). Overall, I'm keen to see this novel study published, however there are some issues (most of them minor) which the authors would benefit from considering:

Line 57-59: I assume you mean "surface atmospheric" temperature
The text has been corrected according to the reviewer's comment (Line 56-57).

Line 58: growing season - I assume you mean aquatic growing season.
The text has been corrected according to the reviewer's comment (Line 57).

Line 118: The assumption of a steady state needs to be explained/justified better.
The assumption of steady-state was specified and explained as following: Assuming that the lake is in steady-state, which means that sum of input DSi fluxes equals to sum of output Si fluxes, thus $\Delta_{DSi} = 0$, DSi concentration in groundwater was then calculated by dividing . . . (L125-126)

I would suggest moving Section 4 before Section 3, but this is up to the authors to decide.
We understand the reviewer's suggestion. However, we believe that having a theoretical section "Numerical analyses" before Material and Methods helps the reader to understand specific types of sampling and analyses. For this reason, we believe that the structure of the manuscript is logic as it is now and we didn't take any action here. However, we will agree on moving these sections if the editor considers it necessary.

Line 314: "average" - replace with "mean"?
The entire manuscript text has been corrected according to the reviewer's comment. All "average" were replaced by "mean"

Line 314: I don't see the need for this sentence - writing about mean sedimentation rates in the core seems unnecessary given the following lines which look at temporal variability in the core.
The sentence now reads "From MAR and BSi wt% we estimated the BSi accumulation

rate (ϕ_{BSi})" (Line 325). We have also added one sentence below, explaining why we do calculate mean BSi accumulation rates from mean MAR and BSi wt%: "The mean BSi accumulation rate for the entire gravity core of 2.9 ± 1.5 mg $_2.cm^{-2}.yr^{-1}$ was used as the BSi flux to sediment in the mass balance models." (Line 327-328)

Line 317-318: I'm confused here:

1. *According to the text in these lines the number of analysed samples is 3 ("n = 3"), but at line 231 n = 25;*
   We have now specified that the mean diatom isotopic signature is calculated from 3 measured samples: n=26 (updated) refers to all measured samples, which includes water and diatoms. We have clarified this by stating that "Each sample was measured three times, bracketed by NBS-28 in between, and full chemical replicates for diatom (n=3) and water samples (n=23) were measured for 65% of all samples (total measurements n=137)" (Line 240-241)

2. *What ages/depths are the diatom silicon isotopes samples? This data should be plotted in Figure 4.*
   We would like to clarify here that the diatom isotope data originate from another core. That is why these data are not plotted in Figure 4, which presents only data from the gravity core. Adding the 3 isotopic data points from this other core in Figure 4 can be done only based on their ages, which is highly dependent on both age-depth models. To clarify this, we have added a sentence (L 219-220) in the Methods section: Clean diatom material (n=3) from a published core taken in 1999 (Shemesh et al., 2001) was used to determine the stable silicon isotope ratio in sedimentary diatoms and then used in mass balance models.

3. *Why is a mean of all diatom silicon isotope samples used in subsequent calculations (see comment further below)? Why not do the mass balance calculations on each sample individually? Doing it individually on the uppermost (core top sample) would be particularly good in providing a value that is more analogous*

to the modern data used in the rest of the paper.
We use mean $\delta^{30}Si$, because the diatom material originates from another core, which is dated by the ^{14}C method, thus the topmost ages of the core are only extrapolated from the age-depth model. Rather than trying to align our ^{210}Pb dated gravity core with the ^{14}C dated piston core, we use the mean. We have no δ30Si diatom data from the gravity core nor 1-cm resolution in the other core from 1999.

4. *Section 6.1 - are modelled seasonal/annual lake level changes feasible and/or supported by observations. Given a modern lake depth of 8 m (line 61), some of these lake level changes seem (to me) fairly extreme.*
   The modelled lake-level changes have high uncertainties as shown in Figure 5 and A1, thus extreme lake-level changes are unlikely to happen, but based on our data, we still do not exclude them.

   Line 337 - this sentence seems very simplistic and would benefit from being explored/ interrogated further.
   This sentence is meant to introduce the assumption for the mass balance model. More details about all processes responsible for the BSi accumulation are discussed in the Discussion section 7.2. We have modified the text according to the reviewer's comment. Now the text reads as: Based on the steady-state assumption, the BSi accumulation occurs in conditions when the total DSi influx is higher that the stream DSi outflux (Lines 349-350).

   Line 341-347: some repetition exists within this section of text.
   Unfortunately, we have not found repetition in this section of text. We are willing to modify the text if concrete suggestions of repetition is suggested (now Lines 354-360).

   Line 354: "ans" = "and"?
   The text has been modified and corrected according to the reviewer's comment (Line 367).

Line 358-366: What happens if you do this for each sediment depth you have a BSI and diatom d30Si sample for? Or what happens if you do this just for the youngest (core top sample)? Would this be better for examining modern silicon fluxes in the lake rather than using mean values over the top 8 cm which covers the last 150 years?

Although the suggestion by the reviewer is interesting, we are not able to do this as we do not have 1-cm resolution of $\delta^{30}Si$. The alignment of the piston and gravity core could be done by comparing the age-depth relationship, however, this is far from being an accurate method as each core has been dated using a different method. This alignment, then, would not increase the resolution, and rather increase the uncertainties for the record, especially for the most recent (the last 150 years) layers. Therefore, we "homogenize" the $\delta^{30}Si$ data for last 150 years.

Line 458: Change "The yearly BSI flux would increase" to "The yearly BSI flux would need to increase"?

The text has been corrected according to the reviewer's comment (Line 482).

Figure 1: add the year that samples were collected to the legend in the bottom right of the right panel.

We have added the years of sample collection into the legend of Figure 1.

Figure 2: Consider using different colours to show the modelled QGW (line 296) and the measured QGW in August/September and then change the figure caption accordingly. Initially, the same colours on the plot for QGW confused me.

We have changed the color of measured Qgw (black cross now) for better readability as well as readability by color-blind individuals and grayscale print.

Figure 6: Use different colours that make it easier to distinguish between each variable.

We have changed the color and symbol (black cross now) of the lake DSi and lake $\delta^{30}Si$ for better readability.

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