Earth Syst. Sci. Data Discuss.,
https://doi.org/10.5194/essd-2019-226-AC1, 2020

Interactive comment on "Remote sensing of lake water volumes on the Arctic Coastal Plain of Northern Alaska" *by* Claire E. Simpson et al.

Claire E. Simpson et al.

clairesimpson17@gmail.com

Received and published: 9 September 2020

We appreciate the reviewers' constructive comments, which we have incorporated in this revision. As a result, the quality of this manuscript has been substantially improved. We have listed reviewer comments and addressed them line-by-line below.

RC1:

1. The authors have measured 17 lakes using the sonar instrument in the study region. However very little is detailed on the measurement part. For example, there should be a table highlighting the number of points measured in each lakes, what is the minimum measured depth, maximum depth measured, etc. Indeed, this can be incorporated in Table 3.

Printer-friendly version

Discussion paper

a. This comment has been taken. We have incorporated the number of points measured per lake into a new Table 1, which also contains maximum and minimum depths measured. We have also added more information in Section 2.1, including information about the frequency of sampling.

2. There is a little information provided on how the authors carried the field survey such as criteria on selection of transects in each lake (how many transects, which direction). we can see that authors pointed that a depth range from the littoral shelf to the deep central basin was captured. However, since this is a data paper, we would like to see all the lake transects in a Figure format (similar to Figure 2a). This won't be difficult as there are only 17 lakes are studied

a. We have added additional information about the transects, including information about the important features of transects in Section 2.1: "It should be noted that, as transects were comprised of individual points whose relationship to one another was unimportant to the modeling, the direction, angle, and other qualities of the transect are significantly less important than the range of depths captured". We have also created the suggested figures showing transects.

3. One photograph showing the sonar instrument mounted on the platform will be useful for readers to visualize the process.

a. Unfortunately, we do not have a good image of this.

4. Authors used Landsat images of 2016 in this study for modeling the bathymetry. Why didn't the authors considered Sentinel-2 images of 2017 July -August, which is having higher spatial resolution than Landsat in this study? This should be clarified.

a. This was a pilot project and at the time that we started we had ready access to Landsat data but did not have easy access to Sentinel. Redoing the analysis with Sentinel could potentially improve the fidelity of the results but is beyond the scope of the project at this time.

5. As mentioned in line 110, authors used TOA reflectance's, which is different from water leaving reflectance. That means, no atmospheric correction algorithm is performed in this work. USGS/Earthexplorer directly providing the atmospherically corrected reflectance products, apart from various other atmospherically corrected algorithms available such as simple DOS, FLAASH, ACOLITE, iCOR etc. Don't the authors believe that atmospherically corrected images may improve the accuracy of predictions as it corrects the haze and specular reflections? This should be clarified.

a. We were partial to TOA reflectance rather than SR as SR algorithms are often sub-optimal when looking at water bodies due to the low level of water leaving radiance. Additionally, SR corrections are not always accurate at high latitudes and can sometimes induce artifacts on water. We did compare the TOA reflectance and SR values at our sample locations and found correlations > 0.99 for the blue, green, and red bands. We have included information into Section 2.2 to explain why TOA was used.

6. "Study lakes were then visually assessed to provide a Boolean turbidity rating for. . .". How to validate this ?. A suggestion is may be used some well known TSM algorithm such as that in Acolite built one (TSM_Nechad) and compare the concentration of TSM in 17 lakes. a. We have incorporated this statistical analysis in the Results section to validate our visual method. As suggested, we used the ACOLITE implementation of the Nechad et al. TSM algorithm, which agreed with the majority of our qualitative turbidity assessments. We also included a discussion of the limits of this TSM analysis (namely that the algorithm was very sensitive to depth) and how we navigated around this fact to obtain relative TSM results for each lake.

7. Validation of modeled bathy results can be performed by drawing profiles comparing modeled vs measured transects (transects used in training cannot be used for validation).

a. Unfortunately with our data, graphs of this nature are visually noisy and hard to interpret. Our transects are not strictly 2-dimensional - they are not straight transect lines, and instead can meander and double back across a lake. This presents a challenge when depicting transects on 2 dimensional graphs as compressing the information to simple distance across transect and depth values shows a distortion and consequentially the transects do not appear on the graph as smooth bathymetry profiles. We did try to visualize our transects on 3-dimensional plots, however these were cluttered and hard to interpret. We will also clarify that we trained and validated our data at the point level, rather than the transect level.

8. Section 2 should be Data and Methods

a. We have changed this.

9. Line 202. "The best models for lakes at which..". Mention which one is the best model here.

a. There is not one single best model, we are instead referring to the best model for each individual lake. We have edited the text to better convey this: "The best model variants for individual lakes at which depth data were collected. . ."

10. Line 239 "Depth was accurately derived from Landsat OLI imagery for individual lakes". How much accurate. Accuracies should be clearly provided in quantified values using RMSE, ME etc.

a. We have specified an accuracy metric in this line: "Depth was accurately derived from Landsat OLI imagery for individual lakes (the average R2 value of the selected models for each lake was 0.82)"

11. Lake bathymetry is continuously reworked, particularly in glaciated regions. This should be discussed in the light of additional field surveys.

a. In the conclusion, we have added a brief discussion of the potential for lake bathymetry to evolve in response to permafrost degradation or hydroclimate changes. This is mentioned in the context of the continuing need for field data and/or dynamic models to understand bathymetry across a longer timescale.

RC2:

General Comments:

1. The presentation of the manuscript is good, but needs some more detail in several parts. These include e.g. the raw data acquisition and software/workflow, preferentially with processing code. It is unclear which software the authors used for data processing/model creation.

a. We have added to the Data and Methods section, e.g. sampling frequency, figures showing transects across lakes, number of points collected at each lake, and noted our use of Python and ArcGIS.

2. The analysis is robust, but rather basic, with only one used image, simple band ratios and simple regression models. The authors may apply more advanced analysis in all these points, which are easily accessible in several software packages of choice (e.g. python with scikit-learn). They would probably help create a regional model. The inclusion of software/platform used, would have helped to provide more specifics.

a. We have added more information about software used. With regards to the simplicity of methods, there is another project in progress that addresses this question and tests some of these other recommended methods.

Line-By-Line Comments:

54: supra lake bluffs?

a. We have changed the wording to “bluffs surrounding lakes” to clarify.

95ff: rather undetailed description.

95ff: Transect lines how dense? Which observation frequency distance between points? I like the method to use a float plane as a platform for taking samples. I think this is very important for fieldwork in the Arctic.

a. We have added more information on this to Section 2.1

106: 2.2. Your database of only one used image is VERY small. I suggest that you use more different images. There should be plenty of data and acquisitions

a. There is very little quality imagery around our area of interest in the relevant time frame. Only a few months exist when our lakes of interest are ice-free and at a relatively similar lake level to the level at the time of in situ measurement (small seasonal fluctuations in lake level exist). Furthermore, many of the images that would have been potentially useful were cloudy and had negative atmospheric effects. Therefore it was difficult to find useful images so we decided to stick with the conventional image-specific modeling approach to obtain more accurate results from the one image rather than try to generalize. As this is a pilot project, we believe that using one image is sufficient for the scope of this work.

107: Does it make sense to merge them initially? I think it is ok to do that later or on the fly, but differences between lakes would be an interesting point to analyze. Spatial sampling strategies would help to make the analysis more robust.

a. The depth points were merged to promote efficient processing e.g. when extracting the spectral values, file reading/editing, and to help visualize them against our image of choice, however each point's lake ID was retained so no data was lost when the individual lake transect points were merged into a single file. Ultimately, we are still doing the bulk of the analysis at the single lake level.

109: TOA data OK as SR is not perfect in high latitudes. Also OK for only one image. Please refer that there are SR data available, but that they come with disclaimer for high latitudes.

a. We have added this information in Section 2.2

111: Interesting that the coastal band did not improve results as it is specifically designed for this purpose as far as I know.

a. agreed

124: maybe you can use a better term than degraded. E.g. merged, resampled

a. Changed to resampled

142: The statement that there was no suitable 2017 image should come earlier, as it is confusing to start stating that you used 2016 imagery.

a. We have added this statement to the sentence first stating the use of imagery from 2016.

162: This sentence sounds a bit unclear and complicated to me.

a. We have reworded to clarify.

187: You mentioned that you merged all data, here you say you have them sampled for each lake. Please clarify.

a. We have added this information to the first sentence in Section 2.2, hopefully this provides enough clarification.

187: I am not sure is a random sampling within one lake is really feasible, as spatial autocorrelation can be an issue. This may lead to an overestimation of your accuracy. However, I understand that input data were taken as a transect and that field work in the Arctic often prohibits more sophisticated/robust spatial sampling design (e.g. grid).

a. We have clarified that the sampling is semi-random at the lake level and fully random at the regional level. We were indeed limited in our collection of sample points by time, location access, equipment, etc.

245: If blue performs well, then the question is why the “coastal” band did NOT perform well, as it is more or less designed for this application.

a. This is a great question, this is a pilot project and therefore we stuck with existing methods of band incorporation, which, at the time of analysis, did not incorporate the coastal band.

281: good point mentioning the limitation of extrema. I would say this is typical for almost all predictive models.

301 ff: I would like to see a discussion about regression models. Are there better models available? More sophisticated one, which take more information into account? E.g. Machine-learning or Deep-Learning models, LASSO, . . .

a. This is a great point, there are certainly more sophisticated models available, and we have been exploring some of these other methods for another project.

Fig 5a: Should "< 0" be "> 0"?

a. These are negatively predicted values due to use of a linear model tuned to less than the shallowest extremes. The representation of negative values is clarified in the figure caption.

Interactive comment on Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2019-226, 2020.