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Biogeosciences Discussions

Interactive comment on "Applicability and consequences of the integration of alternative models for CO_2 transfer velocity into a process-based lake model" *by* Petri Kiuru et al.

Anonymous Referee #1

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Overall, I find this to be useful work. Exercises such as this are not done as often as they should be. However, I am concerned about the model calibration and the overall message of the manuscript. I am unsure what overall message the authors are advocating. They do a comparison of the different parameterizations in a 1D model and leave it at that. The manuscript also has organizational issues which make it difficult to follow. To make this work more impactful, I suggest a section on modeling advice.

Please do not be discouraged by this review. I feel this work can be useful with some reorganization and reframing of the overall message. I very much look forward to reading a revised version.

Specific Comments

I am concerned about the model calibration. During the calibration step, the entire ecosystem is changed for each parametrization. I understand the calibration was intended to capture the surface CO2 concentration. I would consider tuning the model capture some aspect of the ecosystem such as chlorophyll concentration.

It was also not clear why these specific parameterizations were chosen. Some rationale for choosing these specific parameterizations is needed. Admittedly, I am not familiar with most of these parameterizations, so the modeling community could benefit from a description of each. I suggest a section on "gas exchange parameterizations" where you start with a paragraph stating the gas exchange parameterizations and the parameters that go into them. I suggest putting all the parameters in a table with units. Additional sections can be descriptions of each parameterization and where it is currently being used (ie which models use them and which studies use them). Lastly, why wasn't Wanninkhof 1992 used in this comparison? Wann.1992 is the parametrization incorporated into ocean models such as the CESM and MITgcm. MITgcm has been used to in studies of the Great Lakes. Also, the chosen parameterizations are completely different from those used in marine environments (for example, Wrobel and Piskosub Ocean Sci., 12, 1091–1103, 2016). I can't think of any reason why there are different parameterizations for freshwater and marine systems.

I suggest a section providing modeling advice. Differences in gas transfer velocity and CO2 flux using each method are mentions, but there is no consensus on which parametrization the community should be using. I also suggest highlighting more the impact the choice of these parametrizations has on global efflux from lakes.

Technical corrections

- Make it clear GEM stands for gas exchange model. It took me a minute to realize this.
- Add a table stating all the parameters with units used in each GEM - Figures 3 and 5 I suggest a cross plot off to the right with a list of summary statistics (correlation, bias,

RMSE, Nash-Sutcliffe efficiency, etc.) - I suggest a paragraph of modeling advice. How does this work advance modeling of the carbon cycle in lakes? - In the last paragraph of section 2.1.1 make it clear where the temperature dependent solubility comes into play. For this section I suggest looking at Wanninkhof et al. 2009 in annual review of marine science vol1:213-244. - In section 2.1.2 It is unclear where the approximation U10/U1.5=1.22 is used - in section 2.2.2. When you say the model was calibrated against daily averages of automatic CO2, does this simply mean the parameters in the model were tuned to match observed CO2 concentration? Please be clear about this. - In section 2.2.3 : please provide a rationale for this choice “Missing relative humidities were replaced by a value of 75 % in the calculation of the water-side friction velocity” - In section 2.2.4 : All the summary goodness-of-fit statistics (NS, B*, URMSE’*) can be displayed nicely in a target diagram. See Jolliff et al. 2009 “Summary diagrams for coupled hydrodynamic-ecosystem model skill assessment”

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