

Interactive comment on “Determining lake surface water temperatures (LSWTs) worldwide using a tuned 1-dimensional lake model (FLake, v1)” by A. Layden et al.

Anonymous Referee #3

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This paper is a useful investigation into the adjustment of tuning parameters available with the FLake model. The authors demonstrate that the LSWT produced by the FLake model matches observations more closely using their improvements. This has been demonstrated for a large number of lakes, and has applications for extension to modelling of further lakes. This is therefore a very useful study to improve the accuracy of the FLake model for users.

Below I have provided comments in four sections: general comments, more specific comments, figures and tables, and technical corrections.

General comments

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1. Needs an introductory paragraph outlining the application of this work, e.g. use of FLake in NWP etc; why is this work important.
2. Throughout, rename "non-seasonally ice covered lakes" just "non-ice covered lakes" - much less confusing!
3. Table and figure captions should stand alone from text - the reader should not have to look up acronyms and definitions to understand them. Define all subscripts, acronyms and symbols as much as possible.
4. p 8552, line 1: By using an average of the day and night lake temperatures to get your LSWT observation, won't you get a sort of part diurnal signal? Would it not be better to just use either nighttime (no diurnal signal) or daytime (diurnal signal)?
5. "Biases" should really be "mean differences" throughout, as your reference dataset is not necessarily truth.
6. Think about order of sections, and do not keep revisiting same topic if it can be put into one section, e.g. wind speeds.

Specific comments

Abstract: clarify that the tuning is for individual lakes, not one tuning applied to 244 lakes. When mentioning differences (e.g. MAD), need to state differences to what reference.

Introduction:

- p. 8549, line 10: mention Great Lakes too, as these also have a significant effect on the local climate inducing lake-effect snow storms etc.
- p. 8550, line 2: difference to ...what? reference data - ARC-Lake observations
- p. 8550, line 10: Give location of lake (country, or lat/lon)
- p. 8550, line 14: It's confusing here why you would want to use a shallower depth than

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the mean as this is less realistic. This is explained later on in the paper, but perhaps you should refer to this discussion or add an extra sentence to justify this a bit better.

p. 8550: line 21: where do your observed LSWTs come from? (or put this section after you have introduced ARC-Lake)

p. 8552: line 25: replace sentence beginning "Values for other lake" with "Other lake-specific properties adjusted for this study are:"

p. 8553: line 17: what is the spin-up time for the model?

p. 8553: line 26: The light extinction coefficient is one of the tuned properties, so this is very confusing. Do you mean in seasons other than summer? See also p. 8554, lines 4-6. Needs rewording.

p. 8554, line 2: missing "-" in both units

p. 8554, section 2.3.3 - Suggest combining this section with others on wind speed.

p. 8555, line 25: If this is a universal relation, then why change it between 2-10 m? Perhaps reword as the best thing to use if no other information is available.

p. 8556, line 11: What are the figures in brackets? This sentence is unclear.

p. 8557, section 2.3.4: Unclear here why 0.60 is too low, and not clear where this value came from.

p.8558, line 5: Need to define kappa here too.

p. 8559, equation 5: x mean is not defined. N is defined below the next equation, should be introduced here.

p. 8559, section 2.4.4: Suggest putting this at start as introduction. Then can say each part is described in more detail below.

p. 8560, line 3: This still doesn't match particularly well, need to state this.

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p. 8560, line 9/10: Suggest replace \sim half with \sim 50%

p. 8561, line 3: differences between modelled and observed

p. 8561, line 25: reword to make more of this. What did the 25 lakes have in common which makes them not fit? All shallow... anything else?

p. 8561, line 25: is Zd_4 the highest depth factor? Use $Zd_5:Zd_7$ as greater depth factors later on... do you mean shallowest?

p. 8562, line 9: Confused about the tuning modification - implies multiple depths and light extinction coefficients for each lake produce these results?

p. 8563, line 10: Previous section suggests it is not successful - reconcile this.

p. 8563, line 15: reference for this statement needed. Would have thought this effect was negligible.

p. 8563, line 24/ p. 8564 line 4: variance of what?

p. 8564, section 4.3.1: Give $inter_min$, $inter_max$ definitions so reader does not have to look up.

p. 8565, line 6: only looking at 3 months so why is annual range relevant?

p. 8566, section 4.3.2: Why are results better for year with no tuning? Say something about this. Interannual variability?

p. 8569, section 5.2: Explain the the relationship between surface temperature and bottom temperature. What do the FLake profiles look like? Is there mixing, lack of diurnal heating etc?

p. 8659, line 13: suggest "the maximum LSWT and the hypolimnion temperature" changed to "the two layers of the maximum LSWT and the hypolimnion temperature" if I have understood this correctly. The section is a little confusing.

p. 8569, line 24: clarify density gradient is due to temperature difference.

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- p. 8570, line 1: "may show" - refer to later discussion
- p. 8570, line 7/p. 8573, line 15,16, Figure 18: change "lower" to "shallower" as lower depth means deeper. Similarly, "greater" depth should be "deeper" for consistency with this.
- p. 8570, line 21: If there is no hypolimnion in FLake you need to reconcile this with section 5.2
- p. 8570, section 5.4.1: So lake "depth" is not really depth but a tuning parameter influenced by depth. This could be described better.
- p. 8571, line 5: give range as well as means so matches up with the <16 m, >16 m used below.
- p. 8572, section 5.4.3: You recommend alpha3 but have said you use alpha1, alpha2 and alpha3. Need to state something along lines of recommend alpha3 if no information is available.
- p. 8573, line 1: variance of what?
- p. 8573, line 9/10: add "between the *surface layer of* maximum LSWT" as it's the density difference between two layers, rather than a temperature and a layer.
- p. 8573, line 13: without having to tune the model? Surely the improvement is in how to tune the model for new lakes?
- p. 8573, line 28: not "true changes" but rather long-term changes. Short term variability is still a true change.
- p. 8574, line 26: southern hemisphere rather than tropical.

Figures and Tables

Tables 4&5: "with the spread of differences" as you have used +/- you are giving an uncertainty estimate so should describe it as such. Also need to specify that differences

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are between modelled and observed values.

Table 5: Need to reword the caption.

Table 10: Untuned has still been tuned with other parameters - need to say this

Figure 1: Where do the observed values come from?

Figure 2: State Lake Malawi is in southern hemisphere. Make clear the plots are FLake predictions. If you refer to the "upper mixed layer" and "bottom layer" in the caption these should be shown on plot.

Figure 5: At 10 m there is a range of ~50% of y-axis value, so not that close.

Figure 6: Would be good to see a similar plot with observed kappa too. Give country or lat/lon for Lake Geneva.

Figure 7: Would like to see mean depth x 1.0 too

Figure 8: Specify what "model forcing data:wind" equations are for (what categories of size). Need to clarify that e.g. 80 outputs per lake is to do with the various combinations

Figures 9/10: need to refer back to u1, u3 etc in the text

Figure 11: "lakes tuned with modified are" doesn't make sense, reword

Figure 14: write out the default albedo for comparison

Figure 15: need to reword, as "C decrease per week of later 1C warming day" doesn't make sense. More responsive than what? Also, this is only suggested by the plot, as the sample size is very small and therefore can't be statistically significant. Need to be careful with your wording, both here and in the text.

Figure 17: Stated in the text there's a 1:1 relationship but the equation you have supplied gives 1.02 (plus offset). I would suggest just not showing this equation. If lake is stratified, how do surface temperatures match bottom? What do FLake profiles look like? Is FLake forced with observed data here (non-independent)? What does this plot

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look like for other months?

Technical corrections

p. 8550, line 4: global scale study mean does not make sense, reword

p. 8550, line 16: remove comma

p. 8550, line 17: "result" should be "results"

p. 8551, line 3: Last sentence of this paragraph needs rewording.

p. 8551, line 9: "includes" should be "including"

p. 8551, line 22: "demonstrates" should be "demonstrate"

p. 8552, line 19: remove comma after "Although"

p. 8552, line 23: remove semi-colon after "properties"

p. 8555, line 4: "coefficients" should be "coefficient"

p. 8555, line 15: "become" should be "becomes"

p. 8558, line 5: "tuning of seasonally" remove "of"

p. 8558, line 3: "is" should be "are"

p. 8558, line 9: erroneous bracket

p. 8559, line 16: should be "overview of *the* tuning"

p. 8561, line 7: remove the first "default"

p. 8562, line 16: "are" should be "is"

p. 8565, line 7: replace "possible" with "probably"

p. 8566, line 13: add "timing *of the* 1C cooling day"

p. 8566, line 20: remove comma after "lakes"

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p. 8567, line 23: remove "of"

p. 8567, line 24: "become" should be "becomes"

p. 8568, line 2: add "timing of *the* 1C warming"

p. 8568, line 12: replace comma after model with a semi-colon

p. 8568, line 17: add "reduces *the* period"

p. 8568, line 26: replace "being" with "been"

p. 8569, line 3: remove comma after although

p. 8569, line 4: replace "satellite" with "satellites"

p. 8571, line 5: replace "and" with "or"; need "m" after "21"

p. 8571, line 8: add "of *a* deeper"

p. 8571, line 10: replace "scare" with "scarce"

p. 8571, line 15: k used instead of kappa

p. 8571, line 20: remove comma after "runs" and replace "show" with "shows"

p. 8572, line 25: replace "isn't" with "aren't"

p. 8573, line 4: remove "the" from "the annual range"

p. 8573, line 16: remove comma after "18"

p. 8573, line 19: add "place *of the* default"

p. 8574, line 4: replace "quantity" with "quantify"

Interactive comment on Geosci. Model Dev. Discuss., 8, 8547, 2015.

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