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Hydrology and Earth System Sciences Discussions

Interactive comment on "A simple lumped model to convert air temperature into surface water temperature in lakes" *by* S. Piccolroaz et al.

Anonymous Referee #2

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General comments In this paper, the authors develop a predictive model of lake temperature in the epilimnion using air temperature as input data. All other processes of heat exchange in lakes are accounted for by using simplified relationships among them. Overall, the manuscript suffers from extrapolating results beyond reasonable predictions and the authors inadequately develop a "story" that appeals to general readers of HEES. Although all models simplify a system or process they are trying to represent, my main concerns here rely on the oversimplification of the key processes responsible for the heat budget in lakes. Specifically, the "reasonable assumption" of air temperature being the main variable influencing the heat balance of the lake is not "reasonable" (e.g., Schneider and Hook (2010) - Geophysical Research Letters). Rather, in appendix A the authors show most of the model components (i.e., Hs, Ha,

He, Hc, Hp) are strongly related to solar radiation, cloudiness, and wind. But, then the authors choose to simplify the heat budget by emphasizing air temperature which may be misleading especially when predictions of climate change may have the greatest impacts to the overlooked fundamental drivers. Hence, the current version the model is a bit oversold for what it is and the authors still need to address the limitations of the model. For example, the model may be sensitive to spatial variability (not appropriately addressed here). In addition, there is a problem with the mixing of sections (results and discussion) and in some parts the authors should avoid colloquial language. There is some redundancy in the discussion (pages 20-21) as well. A more appropriate review of literature starting with Chapters 5 and 6 from the book by Wetzel "Limnology: Lake and River Ecosystems" Elsevier Press may be useful. I encourage the authors raise these concerns and I hope that they will find this review useful.

Specific comments Page 2 Line 12-13: Atmospheric temperature is not the main factor driving the system. It is well known that solar radiation and wind are more important than air temperature (see the model description in Appendix A and relevant literature). Line 15-16: The authors oversold the model here. In my opinion this model is not recommendable for predictions in the future. There are key factors driving the heat budget that are missing due to an oversimplified approach (e.g., Schneider and Hook, 2010). Page 3 Line 2-4: Please provide proper citations at the end of this sentence. Line 13-14: Please provide proper citations at the end of this sentence. This sentence is also a bit confusing. Line 20: Provide examples of these difficulties. Line 28: But this also depends on cloudiness (e.g., Wake (2012)- Nature Climate Change 2, 230 doi:10.1038/nclimate1480). Page 4 Line 6-15: This paragraph includes some apparent contradictions with the idea that air temperature is a good proxy for estimating lake temperature. For example, the reference of using coarse grid size of GCMs. Line 16-29 and page 5 line 1-10: Since streams and lakes work differently in terms of heat budgets, I recommend eliminating those unnecessary citations from streams and replace them with more relevant and seminal literature from lakes (e.g., see seminal papers cited in the book by Wetzel mentioned above). Page 5 Line 24: But the

model proposed in this study is missing fundamental physical basis (i.e., solar radiation and wind). Page 6 Line 25-26: But similar heat exchange occurs at the interface between the epilimnion and hypolimnion. Page 10 Line 10: If this model is using only one type of data (air temperature) to predict lake temperature the authors should be addressing the spatial variability of air temperature across the area. Page 11 Line 9-10: What other variables are not included? Line 17-18: The location in the center of the lake is reasonable in terms of lake temperature. However, the authors should provide some information of variability across sites with available air temperature (e.g., Standard deviation across sites per month). Line 23: This model is very sensitive to the only predictor used (air temperature). Thus, detailed information of the database used should be provided. For example, a simple table with the proportion of gaps per year and season (e.g., in Table 1 when the missing data occurs). Are the gaps in the air temperature data interpolated? If yes, explain the procedure. Line 27: What is a non-significant gap? Page 18 Line 25: The authors need to provide a less subjective analysis of the "very good agreement" between observed and simulated temperatures. I strongly recommend a simple analysis of the residuals across the range of observed temperatures. Page 19 Line 20-21: The authors cannot argue the benefits of using this model (low error in predictions) because these results are not presented here. The same comment for page 22 line 7-9). Line 23-24: This limitation is in agreement with my previous comment (Page 10 Line 10; Page 11 Line 17-18 and 23). Page 22 Line 14-16: Where are the results to support capturing the inter-annual variation? Also, in page 23 line 22 this part is mentioned and needs to be deleted. Line 20-26: This part is a bit speculative based on the problems of GCMs and the spatial resolution of these models. Only in a few cases of large lakes when the main forces of heat budget (solar radiation and wind) are strongly synchronized to air temperatures may you consider this application. I recommend deleting this part and not using it to over sell the model. Page 23 Line 25-26: This statement is not supported. Rather, the authors could focus on explaining what we gain with this model versus simple correlation models between water and air temperatures? Page 39 Fig. 5: A most relevant analysis should consider

only extreme values rather than every single value. See that most of the differences occur over extreme values. This figure can be improved showing two panels, the first with air temperature and the second with the stream temperature (observed and simulated). Each panel may have a different scale for temperature (lake temperature should be expanded to improve visualization). Similar comments for figures 7-10. Page 45 Fig.11: Provide time scale of measurements (daily values?)

Technical corrections Page 6 Line 5: Provide a short list of these external forces. Line 15: Provide proper citations. Page 7 Line 11: The authors mention that wind is the major driving force, but previously they mention air temperature playing this role. Please, clarify and be consistent with the use of concepts and driving forces. Page 12 Line 1: Provide the temporal scale (daily? weekly? monthly?). Line 10: Provide the software package used to numerically solve the equations.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 2697, 2013.