

Review for « Evaporation from a large lowland reservoir – observed dynamics during a warm summer » by Jansen et al.

Paper summary :

This paper presents a data-driven analysis of evaporation from Lake Ijssel (The Netherlands) over the summer period 2019 and 2020. The overall objective is, first, to determine the key variables driving the evaporation of the lake and, finally, to propose a new parametrisation for this specific water evaporation.

The study is interesting in its approach and aims to fill a gap in the short-term monitoring of the water resource. Based on *in situ* measurements estimated by the accurate and commonly used eddy covariance technique, a simple statistical model is developed and trained to accurately retrieve the summer evaporation of the lake on hourly and daily scales.

General comments :

The manuscript is well written and easy to read, although some sections need to be reworded throughout the paper to improve readability and highlight the scientific contribution of this study.

My main concern is with the overall presentation of the article. I found that the innovative aspect of this study was hidden by general facts and conclusions that have already been proven in the past. I understand the importance of such conclusions in justifying a new parametrisation but, in my opinion, focusing on this key point weakens the overall quality of the article. I suggest that the authors improve the paper to focus on the importance of using the developed parametrisation and to emphasise the need for such a statistical model. In this spirit, I recommend to better integrate this work into the current scientific literature.

Furthermore, some of the results discussed are not presented in detail and it is therefore impossible to review this information. You should either delete these results or provide the details.

All the comments do not call into question the study itself. The material for a good article is already there and just needs some rearrangement and minor revisions. I am convinced that the article will gain in precision and interest with additional information.

Specific comments are detailed below.

Abstract

General comments : In this section, the objective of the paper is not clearly pointed out. In my opinion, you should focus on the specific parametrisation you proposed for Lake Ijssel based on the field measurements. All the elements are already written and you just need to rearrange the section.

-P1.L1 : I would talk about a « sink » rather than a « large loss term ». It is more adequate to the scientific level of the journal.

-P1.L1 : « During summer seasons, which are projected to become warmer with more severe and prolonged periods of drought ».

This is a general sentence whereas your study focused on a specific location. Even if we are on a global climate change path, the consequences (not specifically warmer summer) are not the same worldwide. You should be more specific on the spectrum of warming on the studied area (or region) and put references.

- P1.L8 : « not available energy»
Be specific on the type of energy.

-P1.L11 : « main drivers »
Be specific. What type of phenomenon they are the drivers of?

- P1.L15 : « well performing simple data-driven models »
I would be less enthusiastic with a R^2 of 0.51 and 0.43. The model is adequate but does not perform well.

Introduction

- P2.L1 : There is a more up-to-date review paper you should include:
Woolway, R. I., Kraemer, B. M., Lenters, J. D., Merchant, C. J., O'Reilly, C. M., & Sharma, S. (2020). Global lake responses to climate change. *Nature Reviews Earth & Environment*, 1(8), 388-403.

I would suggest to have a look at the paragraph about lake evaporation which gives essential materials for both your introduction and your discussion.

- P2.L2 : « evaporation is a large loss term of water bodies ... »
I would rephrase by saying this is « a sink in the lake water balance ». Also you should add a reference to justify this, even if it's a validated fact.

- P2.L7 : « Summers are projected to become warmer »
As mentioned for the abstract section, as you work on a specific location, you should be more specific on such fact as you are not working at global scale (mention the spatial scale). Moreover, I would recommend to give the climate reference on which the climatic comparison is made. You should also add a reference.

- P2.L12-13 : « In terms of thermodynamics, ...»

This works on some lakes but this is not always correct. In terms of thermodynamics, big lakes (such as the American or African Great Lakes) could be approached by using either 3D ocean model or 1D model. It will depend on the presence or not of the hypolimnion and furthermore on the stratification dynamic, if there is one.

See :

Xue, P., Pal, J. S., Ye, X., Lenters, J. D., Huang, C., & Chu, P. Y. (2017). Improving the simulation of large lakes in regional climate modeling: Two-way lake–atmosphere coupling with a 3D hydrodynamic model of the Great Lakes. *Journal of Climate*, 30(5), 1605-1627.

Gronewold, A. D., & Stow, C. A. (2014). Water loss from the Great Lakes. *Science*, 343(6175), 1084-1085.

Thiery, W. I. M., et al. "LakeMIP Kivu: evaluating the representation of a large, deep tropical lake by a set of one-dimensional lake models." *Tellus A: Dynamic Meteorology and Oceanography* 66.1 (2014): 21390.

- P2.L17 :

This might be a detail but I would prefer to talk about a change of the amplitude (which suppose an increase of surface temperature during daytime but also a quicker decrease during night-time).

- P2.L21: Lake depth also controls the dynamical range of lake temperature amplitudes on diurnal timescale.

- P3.L2-6 : This paragraph would gain in readability if you reduce the description to its essential. Penman equation is well-known and its description can be shortened. Moreover, this description is redundant with the one on P9.

- P3.L7 : « Most studies ... »

Is this sentence linked with the reference list starting on L9 ? If so, you should move the sentences « However, measurements of... » and « This can partly ... » elsewhere. Also, you said the contrary on L.26 “In the past, a number of studies reported ...”

Moreover, I would not be that direct by saying measurements of evaporation from inland water bodies are under-represented, numerous studies have been published on the subject for the past 10 years:

Potes, M., Salgado, R., Costa, M. J., Morais, M., Bortoli, D., Kostadinov, I., & Mammarella, I. (2017). Lake–atmosphere interactions at Alqueva reservoir: a case study in the summer of 2014. *Tellus A: Dynamic Meteorology and Oceanography*, 69(1), 1272787.

Pillco Zolá, R., Bengtsson, L., Berndtsson, R., Martí-Cardona, B., Satgé, F., Timouk, F., ... & Pasapera, J. (2019). Modelling Lake Titicaca's daily and monthly evaporation. *Hydrology and Earth System Sciences*, 23(2), 657-668.

Moigne, P. L., Legain, D., Lagarde, F., Potes, M., Tzanos, D., Moulin, E. R. I. C., ... & Costa, M. J. (2013). Evaluation of the lake model FLake over a coastal lagoon during the THAUMEX field campaign. *Tellus A: Dynamic Meteorology and Oceanography*, 65(1), 20951.

Blanken, P. D., Spence, C., Hedstrom, N., and Lenters, J. D.: Evaporation from Lake Superior: 1. Physical Controls and Processes, *Journal of Great Lakes Research*, 37, 707–716, <https://doi.org/10.1016/j.jglr.2011.08.009>, 2011

- P3.L27 : I'm not convinced about the utility of the brackets. Moreover you could also include other important hydroclimate variables.

Zhou, W., Wang, L., Li, D., & Leung, L. R. (2021). Spatial pattern of lake evaporation increases under global warming linked to regional hydroclimate change. *Communications Earth & Environment*, 2(1), 1-10.

- P3.L34 → P4.L2:

Woolway et al 2018 & Wang et al 2018 have addressed this issue. Moreover, even if I agree with your assumption, I'm not convinced about such parametrisation for use at longer timescale (for example, seasonal timescale). Lake temperature and evaporation are inter-dependent on such timescales and other hydroclimate variables should also be included.

Woolway, R. Iestyn, et al. "Geographic and temporal variations in turbulent heat loss from lakes: A global analysis across 45 lakes." *Limnology and Oceanography* 63.6 (2018): 2436-2449.

Wang, Wei, et al. "Global lake evaporation accelerated by changes in surface energy allocation in a warmer climate." *Nature Geoscience* 11.6 (2018): 410-414.

- P4.L3 : This sentence is the key point of your study. More generally, the paragraph from L3 to L14 should be the core of your introduction. I would reduce the presentation of the different equation (Penman, Makink) and enrich this paragraph.

Add a reference for this : « a crucial element in its water management system ». Also, you focus on the water management aspect however your paper does not specifically study the impact of the parametrisation on the lake hydrology. I would recommend to add other aspects of the evaporation as a component of the global energy and water cycle. For example, you can talk about the influence on the near-surface turbulence intensity, the stratification or the lake ecosystem.

Raymond, P. A., and others. 2013. Global carbon dioxide emissions from inland waters. *Nature* 503:355–359. doi:10.1038/nature12760

Jenny, Jean-Philippe, et al. "Scientists' warning to humanity: rapid degradation of the world's large lakes." *Journal of Great Lakes Research* 46.4 (2020): 686-702.

- P4.L12-15 : In this sentence, you compare Makking's equation with Flake simulations. I'm wondering why you are not using FLake directly for lake IJssel if you consider Flake simulations as your reference ?

Data, Material and Methods

- P6.L8: It seems that the KNMI station only measure global radiation (as I see in the data provided), however would it be possible to have access to the four components of the global radiation? As shown in Wang et al 2018, the incoming radiation has an effect even if it's at longer timescale.

Wang, Wei, et al. "Global lake evaporation accelerated by changes in surface energy allocation in a warmer climate." *Nature Geoscience* 11.6 (2018): 410-414.

- P6.L30: Could you please rephrase this sentence to improve readability.

- P7.L30-32: “A regression analysis ...” + “To develop ...”
Please rephrase to improve readability.

- P8.L11:

I found difficult to understand the justification of using such regression model and how the hypothesis of such model have been tested.

What are the type of estimator you used (I assume an ordinary least square estimator)? Did you perform a significativity test? It would be interesting to look at the result of the multiple linear regression model and specifically the p_value to include or exclude predictors.

Are the period chosen representative of the population?

- P8.L22: “surface temperature”

Are you talking about the Meteosat product? Hence, why do not use directly these field data? Are there representative of the surface temperature (the lake is shallow then it would be important to be sure the measurements are not performed in the thermocline).

Results

General comments: In this section, I would have a distinct paragraph presenting the results of the calibration, another for the validation and a final one for the result on the routinely measured variables. It would also improve the readability as I had hard time following this section.

- P11.L5; Fig2:

How did you choose the time period presented in the figure? Why do you present this period instead of either the training or validation time period? As I understand your paper is about summer and here you present a part of the autumn season. I admit I was a bit lost. Also I would suggest to be more specific on the time period (e.g: 01/05-31/08 instead of nouns (You write May-August most of the time and once May-September).

- Section 3.2:

In this section, you compare meteorological conditions. It seems you are comparing the air temperature and the wind speed that are are measured at different height. Measurements at Stavoren are made around 7m and around 10m at Trintelhaven. Did you adjust your measurement to an equivalent height? If not, this could explain some of the discrepancies. I have the same question for EC data.

Moreover, you compared these variables to the Dalton model which needs variables at 2m height. What was the procedure you used to adjust the measurements to this height?

- P10.L20: “the water temperature at” instead of “the water at”.

- P10.L18: Please provide the correlation score to justify this is a strong correlation.

- P11. Fig2: Please put the graph corresponding to the 2020 summer period in Appendix.

- P12.L1: I would use the word “pattern” instead of “rhythm”.

- P12.L5: Could you please add the graph in the Appendix?

- P13.L17: Could you please add the correlation score to justify if it's a strong correlation. Also, be careful not to mismatch between correlation and determination when you analyse your results and even more as you are studying a non-linear model. Please rephrase the sentence "Global radiation ..." to account for this difference.

- P14.L4-6: I understand that you only exclude the global radiation from your model based on the R^2 , however, in my opinion a $R^2(\text{VPD})=0.05$ questioned the inclusion of VPD in your model. For example, adding VPD on the Stavoren hourly analysis as a limited impact which is not significant in Trintelhaven.

Does VPD has a significant impact on your score?

- P14.L22: Would it be possible to have some basics statistics on these data (mean, standard deviation, quantiles, min, max). It would also help to see if outliers are ejected from the analysis. A Table placed in the Appendix would be sufficient and would give a hint about the discrepancies between both summer seasons.

- P14.L15: R^2 explains 45% of the variance which is quite low. If you include the water temperature, it reaches 0.48, it is still low but better.

You limit the maximal number of variables for the simple model but in this case it would benefit to your model to add the water temperature.

- P14.L22: "This can be attributed ..."

As noticed in Woolway et al 2021, lake evaporation is highly dependent on weather variability (through its dependence to the lake surface temperature). Your discussion need to stress this issue and not just focus on the comparison to a mean climate.

I would remove this sentence and discuss about this point in the adequate section.

- P14.L26: "this confirms ..."

Rephrase this sentence. If the ingredients are the same than in the Dalton's model why do not use this model or use a calibrated version on your lake?

- P14.L28: "To determine if the coefficients ..."

Without the results of the analysis it is impossible to assess the results. Either give the results or erase this sentence.

- P16.L5-9: "The results for the location of ..."

This is a good analysis of your results. However be sure to be consistent. In your abstract you say that the model performs well.

Discussions

You need to improve your discussions and criticise your result in a more precise way. You could be more exhaustive and include limitations (e.g decomposition of the radiation term, looking at the influence of other hydroclimate variables on the variance).

- P17.L7: You should be more precise and discuss the fact that you do not analyse each term of the radiation budget.

- P18.L6: you can add Le Moigne et al 2016 as a reference.
- P19.L10-13: It is impossible to review this part of the discussion as you don't provide the results. You should either erase the sentence or give the correlation plots.
- As mentioned in the precedent comment (for P14.L22), you are working at short timescale and thus, the lake evaporation is dependant on the weather and the hydrological variability. Your discussion would be more complete by discussing these points.

Conclusions

- P21.L19: In my opinion, your main contribution is the development of the statistical model. I would suggest to rephrase your conclusion in order to account for this.
- P21.L20: Ok but this a general fact and this is not your main result.
- P21.L26-28: Rephrase the sentences to be more precise on the result you use (if it's hourly or daily timescale). It is hard time following which are the R^2 you are presenting.

Editorial comments

- Some sentences lack of consistency and readability. This is often the missing punctuation that is in cause. For example, look at P2.L12, P7.L17, P7.L24, P9.L24, P12.L3.
- Be attentive to have consistency in the form you write the units. The general form is to separate units with a point, ex : $m.s^{-1}$.
- « Focussing » should be written like this « focusing ».
- P2.L8 : parametrise/parametrize and not « parameterise ».
- P2.L26 : add a « to » → « and to represent ».
- P2.L33 and P7.L20: check the tense.
- P4.L25 : use the English structure : 1,100 km^2
- P5. Figure1 :

Increase police size of your scale as it is not readable. Moreover, you should add the label on the contour lines. On the right figure you can erase the y-axis as it is the same than the center figure. Green and white colors for the center and right panels are not adapted to understand where are the land and the water.

Add labels to the windrose.

- P7.L8 : you should either use co-variance or covariance but not both throughout you paper.

- P8.L9 : « variable(s) » instead of « variable(x) ».
- P10 Table 1 : Be sure all the parameters are aligned in the first column.
- P12.L11: “are lacking”
- Please consider improving your Venn diagram in order to gain in readability (police size).