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Earth System Dynamics
Discussions

Interactive comment on "The response of small and shallow lakes to climate change: new insights from hindcast modelling" *by* Francesco Piccioni et al.

Anonymous Referee #2

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The work belongs to the growing number of case studies on lake response to the recent climate change. Here, the authors investigated the long-term trends in a small shallow artificial lake by applying a 3-dimensional hydrodynamic model driven by a 1960-2017 regional meteorological reanalysis dataset. The combination of the study object (shallow polymictic lake) and the approach (a full 3-d model) is particularly interesting for revealing the fine mechanisms and effects of the regional climate change. The results are presented in a clear and straightforward way, but the abovementioned potential of the study is barely unfold. Except one sentence in Conclusions, the motivation for application of a 3-d lake model is not discussed, neither its advantages and disadvantages are discussed compared with simpler 1d models. It remains unclear,

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why should one use such a complicated model, subject to a lot of uncertainties, just to arrive at an obvious conclusion: the lake parts shallower than the mean depth of the mixed layer do not stratify. It sounds like cracking nuts with a sledgehummer. The 3d model performance is only briefly addressed. The validation was performed only on surface (mean) temperature, which is not sufficient to trust the later model results on the stratification trends. The question about the model ability to adequately reproduce vertical thermal stratification in the lake remains open.

A large part of discussion is dedicated to the effect of climate change on the transient stratification development in shallow polymictic lakes. However, the stratification indices used in the analysis—Schmidt stability and the total stratification duration—are rather relevant to oligomictic (di- and monomictic) lakes. Neither duration of the longest stratification period, nor the frequency of stratification events are analyzed. The indices used for the warming effect on the net biological production are also questionable: temerature as a measure of the growing season is weakly justified in lake ecosystems, especially for the climate under consideration. The "number of growing days" (NGD) in the authors' formulation is always clearly above 300, so the whole 365-days long year cycle can be a priori assumed as production-favorable in terms of temperature. Trends in GDD and NGD do not seem to be representative for any biotic processes. In particular, because high temperatures can work as a stress factor inhibiting both primary production and growth rates of higher organisms. In general, Discussion presents a lot of common knowledge but is weakly connected to the results from the study.

In summary: the study uses a promising approach and a solid dataset, but, in its current form, presents little advance on the subject under investigation. A stronger focus on the abilities of 3-d modeling for climatic lake studies and intermittent stratification dynamics of shallow polymictic lakes would strengthen this otherwise well-designed and clearly structured study.

Here are some specific remarks:

- The model uses constant cloudiness as input, which is quite strange, especialy, taking into accout significant long-term trends in solar radiation. Why the real variability of cloud cover (or long-wave atmospheric radiation) was not used? Can you estimate the resulting errors in the model output?

- Also, a constant water transparency is used in the long-term model runs, despite the data indicate a strong transparency variability on seasonal scales. How this assumption affected the model predictions on stratification patterns? Will the time-variable Secchi depth change the modeling results?

- I do not believe that the trends in solar radiation and wind are monotonic (Fig. 3bc). A change point detection analysis should be performed here (e.g. B.K. and Tsay, R.S., 2002. Bayesian methods for change-point detection in long-range dependent processes. Journal of Time Series Analysis, 23(6), pp.687-705., or any other similar approach) with subsequent piecewise trend estimation.

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