

## ***Interactive comment on* “Future projections of temperature and mixing regime of European temperate lakes” by Tom Shatwell et al.**

### **Anonymous Referee #1**

Received and published: 28 December 2018

Shatwell et al., “Future projections of temperature and mixing regime of European temperate lakes.”

### General comments

In the present paper the authors examine the response of 4 European lakes to global warming. The study is based on numerical simulations where RCP45 climate scenarios of several global models are used as lateral boundary conditions to the RCA4 regional climate model. This ensemble is then used to drive the one-dimensional lake model FLake simulations and study the evolution of surface temperature, ice cover and wind-mixing regimes. The authors demonstrate a warming tendency of the selected lakes and a change in mixing regimes. They also highlight the key role of transparency and the seasonal link with stratification and mixing.

The manuscript is well structured and written, the demonstrations are satisfactorily conducted and the discussions of interest. However, there are some specific questions I would like to be answered before accepting the manuscript for publication.

### Specific comments

The title does not completely reflect the content of the manuscript. As stated by the authors it turns out to be very difficult to generalize their conclusions due to the wide variability of lakes and behaviors. European temperate zones extend from the Atlantic Ocean to the Black Sea and are bordered to the north by the boreal zone and to the south by the Mediterranean. The impact of climate change may vary substantially in such a wide region. It would be more appropriate to limit the scope of their conclusions to the 4 studied lakes. I suggest to modify the title accordingly.

Global climate scenarios are used as is without considering bias correction of any kind. Even if this is probably true that the way how to correct climate simulations is debatable, the climate response of individual lakes is mainly driven by air temperature. RCA4, like the other regional climate models is biased in temperature (Strandberg et al. (2014): CORDEX scenarios for Europe from the Rossby Centre regional climate model RCA4). How does RCA4 temperature bias affect the conclusion of the current study?

Precipitation is not mentioned as input to FLake model. However, in winter snow can reinforce substantially lake insulation in presence of ice. In RCA4 precipitation is also biased. Is the snow module activated in FLake? Please add a comment on that particular point and discuss how snow could modulate the conclusions of the paper, at least in the close future before the warming prevents ice formation.

Flake is calibrated with ERA-Interim data, it is not clear however which calibration period was used: figure 3 indicates 1996-2002 but this is not explicitly stated in the paper.

Calibration of FLake parameters allow correcting biases in ERA-Interim forcing (Biases due to daily variables, to sub-daily interpolation, etc.). For the future period 2020-2100,

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it is not proven that these calibrations are best when forcing is made with RCA4. I encourage authors to compare RCA4 model runs for present period with and without calibration, using ERA-Interim as lateral boundary conditions, and discuss the impact in terms of surface temperature, icing, wind-mixing regimes, etc.

In Müggelsee a specific calibration is performed to account for a water supply from a connected river. Is there any signal in climate simulations that confirms this river discharge will be as important as in the present climate? A smaller discharge in the future (due to less precipitation, more evaporation, etc.) would for instance impact transparency and change the calibration results.

In figure 9 only the 2050-2059 period is considered? Are the results also valid for the other time periods? Please add a comment on that point page 10.

The ensemble of 12 members is not discussed in terms of dispersion: a rank diagram of air temperature is probably very important to discuss the ensemble model dispersion and demonstrate this ensemble is enough-dispersive to represent the climate variability.

Sine data are used to reconstruct wind which is a key variable for the mixing-regime of lakes. It is not clearly proven how accurate wind reconstruction is and how it compares to Potsdam dataset. Please indicate Potsdam location in Figure 1.

Temporal downscaling of humidity is performed linearly. Is it relative humidity that is considered as input to FLake? Usually specific humidity is used. Please clarify.

In the presentation of FLake model runs, it would have been helpful to clearly explain which time step was used: sub-daily variables are constructed but then is the atmospheric forcing 6-hourly, 3-hourly, etc.?

Technical comments

Page 9 line 9: ensemble

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Page 12 line 25: transparency

Page 12 line 28: Heiligensee

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2018-588>, 2018.

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