Hydrology and Earth System Sciences Discussions

Hydrol. Earth Syst. Sci. Discuss., referee comment RC1
https://doi.org/10.5194/hess-2022-312-RC1, 2022

Comment on hess-2022-312

Anonymous Referee #1

Referee comment on "Sources of skill in lake temperature, discharge and ice-off seasonal forecasting tools" by François Clayer et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2022-312-RC1, 2022

This article treats the important and so-far under developed field of seasonal forecasts (here 4 months into the future) of lake and drainage area properties including water temperature, ice-off, and river discharge. The authors combined two lake models (simulating surface and bottom temperature and ice cover, two lakes each) with four Hydrologic models (simulating discharge, one drainage area each). The method was applied at four lake-river system located in Norway, Spain, Australia, and Germany. Modeled systems include lakes spanning 19 o 60 meters depth and with a retention time from 0,2 to 1,1 years.

The coupled model setup was calibrated towards measurements (lake temperature and river discharge) and forced with reanalyzed data from ERA5, I would define this as a general circulation model (GCM). Hydrological-lake model performance was evaluates with KGE, NSE and RSM. Thereafter calibrated models was spun-up during one year and forecasted discharged and lake surface and bottom temperature during four months (one month initialization) spanning 13 years (1993-2016). Future forcing comes from 25 forecasts from the global forecasting tool SEAS5. SEAS5 was bias corrected and downscaled (grid adjustment) towards ERA5 to enable comparison.

The correctness of the forecasts (Lake_F) was evaluated trough a sensitivity analysis, comparison of Lake_F towards in-situ measurements and towards daily pseudo-observations (Lake_PO, daily output from the coupled hydrological-lake model setup forced with ERA5). The end product of this manuscript consist in an evaluation (sensitivity analysis), of forecasting correctness for each river-lake system and a evaluation of forcing parameters influence on forecasts.

The manuscript show potential but is lacking in some areas which I list hereunder.

Chosen drainage areas and lakes

The authors put forward that seasonal predictions work best next to the equator and worsen with increased latitude (line 50 to 58). Yet, no system was chosen in this region, Spain being the closest. The manuscript could still benefit from an analysis of latitudinal effects for the used forecasting method to improve forecasting towards the North/South pole.

Additionally, the river-lake systems chosen contain lakes with very short retention time, i.e. big impact of rivers on water constituents, including temperature. The model method used include the effect of changing lake volume, but not the effect of heat being transferred into the lakes by upstream drainage area (input temperature I could not find). Thereby it is reasonable to assume that the lake models (through calibration) had a better connection between surface and deep waters than is the in-situ case. Could this show up in your analysis of forcing parameter importance ("Tracing of forecasting skill" section 3,4, Fig. 4)? This needs to be addressed/analyzed since you link forcing to lake processes, which in fact could be caused by upstream heat fluxes in the drainage area and not in the lakes themselves.

Data

This manuscript use ERA5 reanalysis as a stand in for in-situ measurements. Why is this, due to large spatial extent of drainage areas? If possible, show how this influence your modelling locally, or refer to documents where the reader can find this comparison between ERA5 and in-situ measurements, in best case for the regions being analyzed.

Clarity

The manuscript could benefit greatly from an index defining the many acronyms used, as well as improved description of tables and figures. Ex Table 4 and 5 is hard to understand.

Furthermore, I could not find/understand if the drainage area and lake models are coupled in time (run simultaneously), or if the drainage area models where run in advance to provide discharge for the lake models.

The language

Certain words in the manuscript cause some confusion. Bellow I have stated some that might need to change

Skill – is associated with people. A fast car (a tool) has no skill it has performance, the driver on the over hand has skill. That said, I know skill is used more commonly to describe models (tools) in meteorology than hydrology. So I suggest that you define what you mean by skill if you want to keep this formulation.

Climate & climate prediction – studies involving effect of climate focus on longer time periods (>30 years) than what is the focus in this study (<1.5 years). Both SEAE5 and ERA5 comes from global GCM models, which could be used for climate studies. But in the context of this manuscript I do not think this is the right phrase describing the models you used.

Hindcasts – is usually used in the setting of running models with data from past events, close to reanalyze with the aim to improve said models. Here this word is used in combination with SEAE5 forecast simulations. The authors have adjusted these to ERA5 (real data proxy) but the intention is still to use SEAE5 as forecasting forcing. Therefor consider other alternatives in the manuscript, or define this word in the context of your manuscript.

Water quality – for drinking water and the biosphere, temperature is considered an important water quality parameter. Here we do not look at lakes and rivers in this sense, water quality one would assume here to entail dissolved constituents (nutrients, oxygen…). To avoid misunderstanding, consider using something else.

Line 19 : “as previously presented”. Avoid need for reference in abstract.

Line 67 : Consider adding the following reference
https://doi.org/10.1016/j.watres.2020.115529

Line 72 to 74: partly untrue, air2water can run perfectly with seasonal forcing as you do here (only air temperature as forcing), and ice-off is currentl available indirectly.

Section 2,1,1 : The reader do not know where the lakes and drainage area (rivers) under investigation is situated. Add a map showing the global location and regional extent of each drainage area-lake system (rivers and lakes). Additionally add these system details (names, stations, etc.) where appropriate, ex. Table S1.

Line 111 or 112 : add reference: SEAS5: the new ECMWF seasonal forecast system. Stephanie J. Johnson, (2019), https://doi.org/10.5194/gmd-12-1087-2019

Line122 to 123 : „Climate data where downloaded….”. What do you mean in this sentence, ERA5 and/or SEAS5?

Line 134 to 135 : If true that hydrological and lake models were chosen due to local lake/river conditions as I understand from your text, state which conditions and why. I suspect that local infrastructure, i.e. local people (authors) knowledge/experience with chosen models, determined which was used (which is a valid reason if that is the case). Using multiple models is a strong supporting point for this manuscript.

Line 139 “)” missing

Line 156 to 157 : Add details (equations and ex. RMSE) of this linear regression between in- versus outflow.

Figure 2. consider showing mean of SEAS5 predictions and ERA5 at the same time (i.e. continue black lines into transition and target season).

Line 185 : RPSS looks to be missing from table 2 and table 3.

Line 235 to 238 : something is missing here, hysteresis should make linear relationship between ex. air temperature and water temperature rather bad. Describe how good these linear fits were (in appendix). And/or show with figure and improve explanation.

Line 243 the reader are not familiar with the contributions of local heat fluxes at the chosen locations. Before disregarding for example cloud cover from the analysis, show the reader in numbers (or preferably figure as appendix) for each lake the seasonal heat budget contributions. I.e. uptake and emission of infrared longwave radiation, evaporation + condensation, sensible heat flux and uptake of surface downward solar radiation. Throughflow you only have the outflow (at some lakes?) since inflow temperature is missing.

Line 250 : RMSE not consistent with RMSE/sd in Table S2. What is RMSE/sd? Use the same in text as in Table S2.

Table 5. move description of asterisk under table and improve the site representation. Now you can not see what belongs to which system. And define the season duration.

Figure 3 and 4 : missing Germany and Australia, add or explain.

Figure 4 : Something do not add up in your analysis. Top row for Spain – Bottom temperature, and Norway - Surface temperature appear to be to large compared to the individual season values taken together. I.e. if the impact is small most seasons, I do not see how it could e much larger on an annual basis.

Figure 5 : Why so many data gaps? Consider showing seasons where significance is worse (higher) but clearly state which significance level you trust.

Line 468 : add author contributions. Who did what?