We would like to thank the constructive comments, please find our replies below. Our replies are marked in red, our corrections in the manuscript text are in green.

Reviewer 1

This paper about lake level modelling presents an interesting case study with a clearly presented methodology that could readily be transposed to similar cases with little in situ data. The method is overall well presented and the implications for the case study nicely discussed and summarized in the conclusion; the literature review in the introduction is well written; it remains perhaps a little unclear how relevant / important similar case studies are: is a comparable modelling of lake systems a common problem? would most lake systems not be rather different, with numerous hillslopes connected to the lake that require an actual rainfall-runoff modelling part to account for surface inflow? It would perhaps be interesting to check what cited literature refers to similar low land lake systems (without surface water inflow) and which ones to more mountainous / alpine lake systems.

In the area of Brandenburg, East Germany we are aware of at least 5 lakes with no, or very limited surface water connections that are exposed to similar lake level losses: Groß Glienicker Lake, Sacrower Lake, Großer Seddiner Lake, Peetschsee, Straussee. The study of (Lischeid et al. 2021) examines more similar examples from a larger region over East Germany.

Many of these lakes used to have surface water connections, which were dried up due to lake level loss in the last few decades. We think this shows the relevance of such cases, as they will become more and more abundant in the near future.

We modified the study site description as:

"Both lakes are groundwater fed, with no active surface water connections, similarly to multiple lakes in the region (Lischeid 2021). A connection between the two lakes used to exist, but it has been closed in 1996 due to the declining levels in both lakes."

We would also like to note, that the used approaches are not restricted to lakes without surface inflow. Even so, the used data-driven methodology was mainly motivated by data-driven rainfall-runoff modeling studies. We extended the conclusion part with a potential outlook to this direction:

"The shown approaches are not limited to lake systems without surface water inflows, but can be used for low land lake systems in general."

Detailed comments:

- the balance equations are not well presented; they are a mixture between actual water balance equations and their numerical implementation; please check all units and make sure all quantities have the same units in all equations; do not mix fluxes (in units of volume or mm per unit time) with storage

We have corrected this section.

"The water balance equation for a groundwater fed lake system can be formulated as:

$$\Delta S_{lake}(t) = P_{lake}(t) - E_{A,lake}(t) + F_{in}(t) - F_{out}(t) + \epsilon \tag{1}$$

where ΔS_{lake} is the change in lake water storage, P_{lake} is the total precipitation over the lake and $E_{A,lake}$ is the total lake evaporation. F_{in} and F_{out} are in this case the subsurface in- and outflow of water to the lake, which can be combined into the net subsurface water inflow (ΔF). The final term ϵ explains any remaining errors and uncertainties in the data. If there were any surface water connections to the lake, an extra net surface water inflow would be required to account for it.

Precipitation ($P_{catchment}$) and actual evapotranspiration ($ET_{A,catchment}$) over the (groundwater) catchment area, and not just the lake, strongly influence subsurface flow processes that feed the lake. However, these effects show some time delay. Therefore, the water balance equation for the catchment reads as:

$$\Delta S(t) = \int_{t-\tau^*}^{t} P_{catchment}(\tau)\, d\tau - \int_{t-\tau^*}^{t} ET_{A,catchment}(\tau)\, d\tau + \Delta F`(t) + \epsilon \quad (2)$$

"

- "in this study we used a lowpass filter over the lake level data, with a cutoff frequency at 20 days to help with the visualization of the analysis." I would not be able to reproduce the filtering with only this information; filtering comes again later, can you give more indications? is it always clear in the results if the shown data filtered or not?

A zero-phase Butterworth filter was used with a cutoff frequency at 20 days to support the interpretations of the linear regression model.

We thought it interesting that the methods presented in the study were not sensitive to the filtering at all (which is a big contrast compared to machine learning methods for example). Filtering was only relevant for some of the figures relevant to the method illustration. We double checked to make clear where the filtered data was used.

"In this study we used Butterworth filters from the scipy.signal python package. For the autocorrelation analysis in section 4.1 a bandstop filter is used, that removes the 365 days period signal from the lake level data. For the plots of the linear regression analysis (Figure 6,7,8 and 9) a lowpass filter was used over the lake level data, with a cutoff frequency at 20 days to help with the visualization of the analysis."

L312 "A bandstop filter is used over these data to remove the annual cycle, which dominates the lake level periodicity and could distort the analysis."

L364 "The lake level data is filtered using a Butterworth filter with a 20 day cutoff frequency."

- does the system not have surface water in- and outflow? this is not clear in the methods part; it becomes clear in the case study section but this is unusual for most hydrologists, could be made clearer

The system does not have surface in and outflows. There used to be a stream upstream, and a canal connection downstream to the Sacrower Lake, but they both dried out due to the level loss in the last decades.

We have emphasized this property in the methodology section line 182:

“If there were any surface water connections to the lake, an extra net surface water inflow would be required to account for it.”

- results: there are details that belong to the methods section, in particular the applied filter to remove the annual signal requires more details; as is, this part is not reproducible; how does the signal look like after the annual signal removal? the part on estimating optimal memory should have a reference

We have added more the details to the methods (see our earlier reply).

“The k-lag autocorrelation shows the time dependence of the lake level data, and give a good indication of the ideal memory timeframe for the modeling (Seeboonruang 2015).”

- testing memory length up to 250 days does not seem to make a lot of sense a priori; why could the system have such a a long memory? what explains the decrease of the metric after 100 days in figure 3?

This was an empirical choice, the length of the timeseries and the small computational costs allowed to analyze longer memories. This was especially relevant during the exploratory phase of our study, when we tested out other methods as well that were more sensitive to memory (such as machine learning approaches). At longer timelags we would be able to see if there are any major periodicities, or maybe the impact of larger scale groundwater systemic effects.

“Then the fit quality reaches a plateau until about 100 days when it starts to decrease again due to additional cyclicity in the data.”

- results, line 333: an actual equation of the numerical scheme would be preciser (with correct time steps)

We modified this section as:

“The water balance model is built using eq. 1 on a monthly scale (30 days scale) – suggested by the system memory analysis. The monthly precipitation ($P(t_m)$) and actual evapotranspiration ($ET_A(t_m)$) timeseries are generated via summing up the daily values, and the lake level timeseries (which is used for model validation) is averaged to monthly means. The monthly weather values are then compared with the mean lake level of the next month ($\Delta z(t_{m+1})$).

$$\Delta z(t_{m+1}) = P(t_m) - ET_A(t_m) + \Delta F` \quad (10)$$

”

- line 344: from figure 4, I get that there is too much water in the system, thus line 345 should read that an additional groundwater outflow is required? perhaps I misread the text here, please check

We have corrected this in the revised manuscript.

- line 386: how do you standardize? the daily time series, how? how can you standardize a time series with many zeros such as precip)?

We used the StandardScaler function from the scikit-learn python package. This is a scaler function modifies the values of the timeseries to approximate a 0 mean normal distribution. As this is just a scaling of the timeseries, the precipitation does not cause any major issues, but the resulted timeseries indeed have a skewed distribution.

- line 400: the process description is as if we had a very simple system with a single groundwater system directly connected to the lake; is this the case? very unusual for most hydrologists, for a catchment of 33 km2.

Our current understanding is that the Groß Glienicker Lake has connections to two aquifer layers, that are also connected to each other. There are ongoing studies within the framework of our research project that is focusing on the understanding of the complex groundwater system.

Our presented approach tried to show that to understand the lake level dynamics such complex understanding is not required. The here presented simple process describes the behavior of the simplified model we used. The results show that the majority of the dynamics can be explained with this simplified setup, as shown by the good model fits.

The discrepancies between the model and the observation that provided the basis of our discussions shows that the catchment is indeed not as simple as it may seem by the model.

References

Lischeid, Gunnar (2021): Abschätzung des mittelfristigen Niedrigwasserrisikos anhand der Daten des Grundwassermonitorings. In *KW Korrespondenz Wasserwirtschaft* (12), pp. 780–785. DOI: 10.3243/kwe2021.12.004.

Lischeid, Gunnar; Dannowski, Ralf; Kaiser, Knut; Nützmann, Gunnar; Steidl, Jörg; Stüve, Peter (2021): Inconsistent hydrological trends do not necessarily imply spatially heterogeneous drivers. In *Journal of Hydrology* 596, p. 126096. DOI: 10.1016/j.jhydrol.2021.126096.

Seeboonruang, Uma (2015): An application of time-lag regression technique for assessment of groundwater fluctuations in a regulated river basin: a case study in Northeastern Thailand. In *Environ Earth Sci* 73 (10), pp. 6511–6523. DOI: 10.1007/s12665-014-3872-7.