Referee general comment:

This manuscript describes a one-dimensional model (i.e. GLM-AED2) study for Lake Mendota which analyzed its long-term changes of anoxia and the driving factors. As a major result, the model showed good performance in reproducing oxygen dynamics, especially the low oxygen concentration in the hypolimnion,in the lake and based on the statistical analysis, it suggested that the physical structure (e.g. Schmidt Stability, onset of stratification, water temperature in the hypolimnion) had a big influence on the spatial and temporal development of anoxia. This is an interesting and important study, which could be considered for publication after a minor revision. Although there are quite a few studies analyzing hypolimnetic anoxia for inland waters, most of them draw their conclusion based on the short-term measurements and there is still a need to comprehensively illustrate this phenomenon and mechanisms behind its formation based on long-term database. Based on this prospective, this research fills in a research gap. In my opinion, this paper is well organized and its content, especially the discussion part will improve our understanding about anoxia and its future development under climate warming. Detailed comments are shown below.

Referee comment:

2.1 Study Site: It is better to show a topographic map of this lake, as well as the location for the water quality measurements.

Author response:

Thank you for this suggestion. We have added a new figure to the manuscript that shows the location and landuse overview of Lake Mendota, as well as the location of the measurement stations.

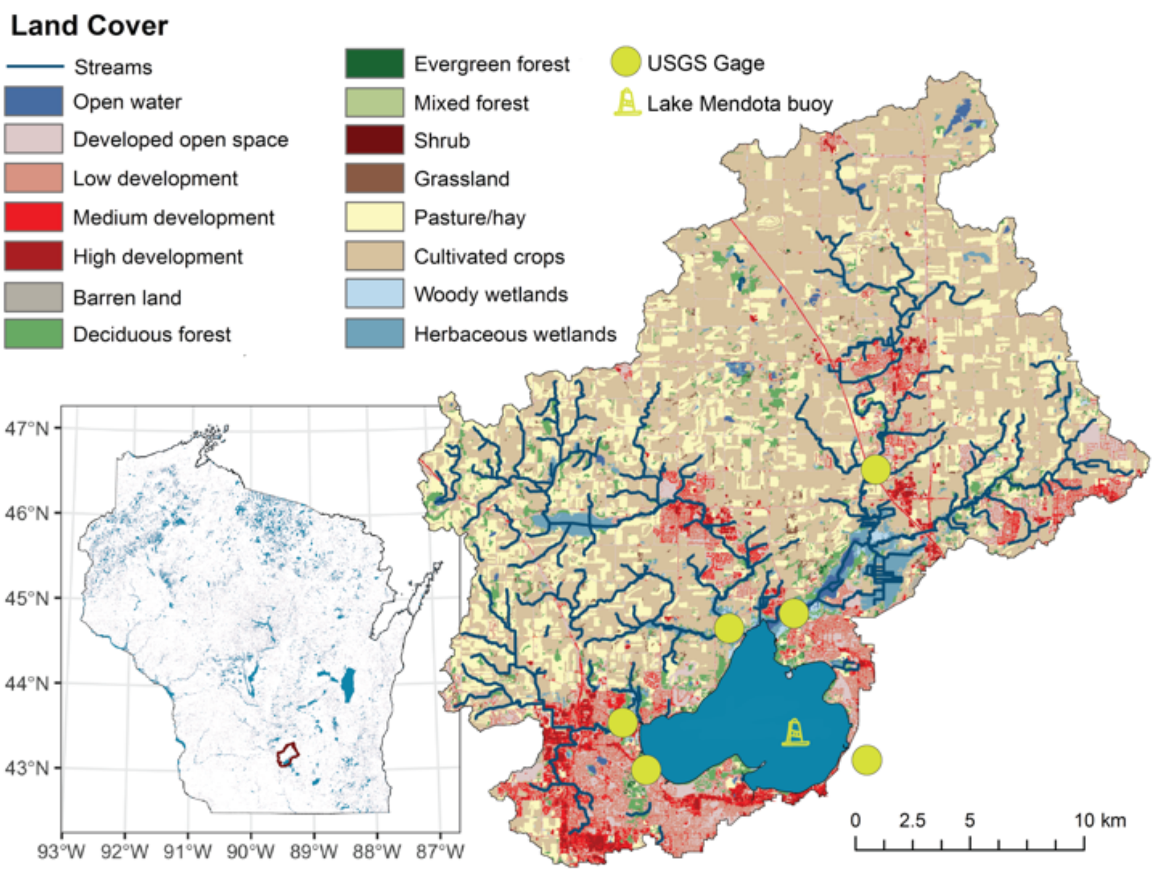
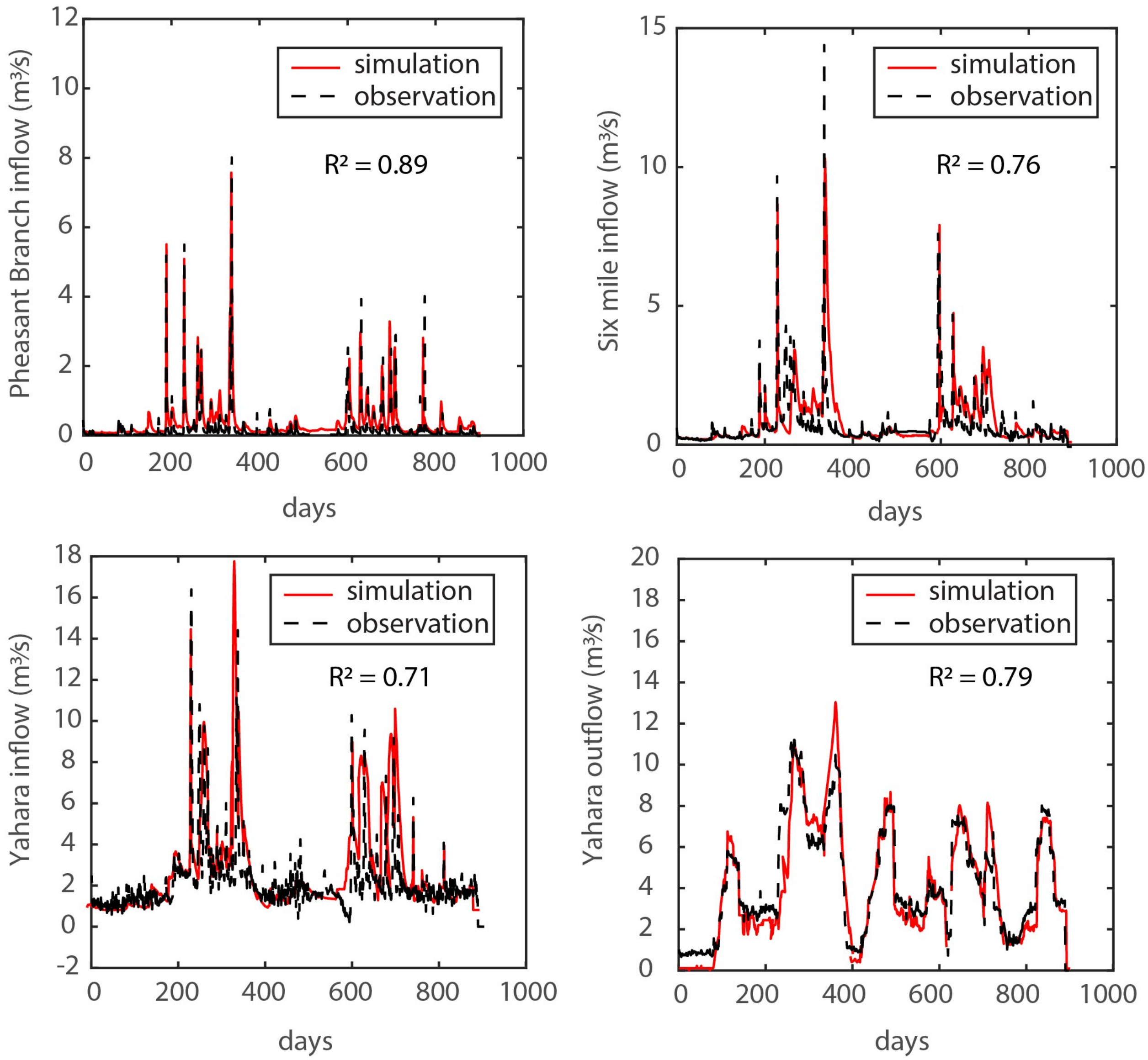


Figure 1 Location and overview map of Lake Mendota, Wisconsin, which is located in the Yahara River catchment in southern Wisconsin, USA. USGS gage stations for the PIHM-Lake model and the location of the Lake Mendota monitoring buoy are placed in the map. Land cover was obtained from the US National Land Cover database.

Referee comment:
L 115: 1.How you calibrated the hydrological model?
Author response:
The hydrological PIHM-Lake model was calibrated to measured stream inflows to the lake and outflow discharges from the lake to the catchments. The model was calibrated by using the observations from 2009 to 2011 and validated by using the measurements from 2012 to 2014, within which all stream flow observations are available. To state this clearer in the main text, we slightly modified this sentence in the manuscript:

> L125: The PIHM-Lake simulation covers a 37-year period (from 1979 to 2015), and its parameters were calibrated and validated with *in-situ* measured stream inflow and lake outflow discharges from the US Geological Survey.

We also attached the following figure to this reply here, which shows the fit between observed discharges of three Lake Mendota inflows (Pheasant branch, Six Mile, Yahara) and the outflow from Lake Mendota to the simulated discharges by PIHM-Lake (calibrated).



Referee comment:
2.From I know for the historical simulation, the inflow discharge is always drawn from the real measurements, instead of hydrological models. Do you have the measured inflow discharge for Lake Mendota?

Author response:
Yes, we have used measured inflow discharges for Lake Mendota at 4 inflows gages, see Fig. 1, but these monitoring stations only present an incomplete water balance as all groundwater inflow and surface overland flow to Lake Mendota are not observed, which could also contribute to the water balance of Lake Mendota. Therefore, we additionally used a calibrated hydrological PIHM-Lake model (using monitored flow data and lake surface water level fluctuations) to create two general inflows terms that close the overall lake water balance. To clarify this, we have added a sentence to the main text:

> L127: The application of the PIHM-Lake model for quantifying the lake inflows helped closing the water balance of Lake Mendota as groundwater inflow and surface overland flow were not measured, and the model simulations provided these inflows.

Referee comment:
L 125: How many types of nutrients were included here as the inflow boundary conditions? It is better clarify it here.
Author response:
Thank you for pointing this out. We included a sentence in the main text:

> L133-136: We included the following nutrients in the inflow boundary conditions soluble reactive phosphate, adsorbed soluble reactive phosphate, dissolved organic phosphorus, particulate organic phosphorus, dissolved organic nitrogen, ammonia, nitrate, refractory dissolved organic carbon, dissolved inorganic carbon, and reactive silica.

Referee comment:
L133: I am not sure whether it is appropriate to define the inflow loading as the mean values from the water column. It means that there is no seasonal changes of DIC and silica, which is unrealistic. Could you explain why you set the inflow DIC and silica in this way?
Author response:
After a long internal discussion, we set DIC and silica to an average value as these variables are not part of the routine measurement program. As the average in-lake value is quite high, we did not expect any sensitivity of these values on the model results. Further, in-lake measurements have shown that the average concentration in the lake does not fluctuate much.

Referee comment:
2.3 Modelling Framework: Just a recommendation, it may be better to combine 2.3 to 2.7 into one part, since all of such content be longs to the model description.
Author response:
In accordance with the reviewer's suggestion, we changed the levels of sectioning of these paragraphs, e.g. "Deductive Model", "GLM-AED2", "Post-Processing of GLM-AED2 Output" and "Regression Model" are now all sub-paragraphs of "2.3 Modeling Framework".

Referee comment:
L 198: For water temperature simulation, I supposed the most important parameters should be wind factor and light extinction coefficient. How you defined these two in the model?
Author response:
For identification of calibration parameters, we used the Morris Sensitivity method, which declared the short-wave solar radiation factor, the long-wave radiation factor, the bulk aerodynamic sensible heat transfer coefficient, and the sediment temperatures as the most sensitive model parameters. Therefore, we did not calibrate the wind factor and left it a 1.0, e.g., we used the measured wind data from a close airport. The light extinction coefficient was set to a low water background value of 0.1, because the value was dynamically changing in the water quality model AED2, which backfed any changes in light extinction due to abundance of dissolved substances to the hydrodynamic model. We checked the dynamic modeled light extinction values with measured Secchi depth data, and the seasonal dynamics were replicated by the model.

Referee comment:

L 293: How you calculated GPP? It is better to clarify it here.

Author response:

GPP (in mmol C per m3 per d) was internally calculated by the AED2 model as the daily total carbon uptake of all functional phytoplankton groups. We clarified this in the main text:

> L300-308: Here, GPP represents the sum of all functional phytoplankton group's photosynthesis rates parameterized as the total carbon uptake:
>
> $$f_{uptake}^{PHY_C} = R_{growth}^{PHY}(1 - k_{pr}^{PHY})\ \phi_{temp}^{PHY}(T)\ \phi_{stress}^{PHY}(X)\ min\{\phi_{light}^{PHY}(I)\ \phi_{N}^{PHY}(NO_3, NH_4 PHY_N)\ \phi_{P}^{PHY}(PO_4, PHY_P)\ \phi_{Si}^{PHY}(Rsi)\}[PHY] \quad (7)$$
>
> where the carbon uptake $f_{uptake}^{PHY_C}$ of an individual group *PHY* depends on the growth rate R_{growth}^{PHY}, the photorespiratory loss $(1 - k_{pr}^{PHY})$, temperature scaling $\phi_{temp}^{PHY}(T)$, metabolic stress $\phi_{stress}^{PHY}(X)$, and a minimum function taking into account limitations by light $\phi_{light}^{PHY}(I)$, nitrogen $\phi_{N}^{PHY}(NO_3, NH_4 PHY_N)$, phosphorus $\phi_{P}^{PHY}(PO_4, PHY_P)$ and silica $\phi_{Si}^{PHY}(Rsi)\}$ (Hipsey et al., 2017; adapted from Hipsey and Hamilton, 2008). As the GPP is the main model output variable for phytoplankton dynamics, it scales directly with biomass and Chl-a concentrations.

Referee comment:

L 333: There existed some negative values for Birgean Work in Figure 5, what is the reason for that?

Author response:

As the Birgean Work is

$$B = \int_0^{z_m} A_z(1 - \rho_z)zdz$$

a negative value can occur when a dominant part of the water column has water densities that are above 1,000 kg per m3. Hypothetically speaking, a negative Birgean value would mean that no energy is needed (or negative energy would be needed) to achieve the current stratification from a completely mixed state, which means that the current state is probably also completely mixed. We decided against discussing this in the manuscript as we focused on oxygen dynamics over time.

Referee comment:

L 371: In Figure 9B, why was the simulated AF represented by dots, instead of box plots as the measured one?

Author response:

The simulated AF is represented by dots as we calculated it from the GLM-AED2 output and were therefore able to quantify it using daily data. On the other hand, the observed data were only available every two weeks, therefore we used different interpolation techniques to get daily data. These uncertainties were captured in a box-plot.