We thank you very much for the constructive and helpful comments on our manuscript. The comments (bolded) from the reviewer Dr. Zeli Tan are fully addressed in the following.

It is an interesting study. Because a 1-D lake model is still much needed to understand the impact of climate changes on global lake systems, a parameterization method that could improve the simulation of lake mixing process will be much valued. But I suggest that the manuscript can be improved in the following directions. First of all, the comparison between CLM-ORG and CLM-KPP is not exhausted, to day the least. In Subin's CLM-ORG paper, he actually tested the model over a pair of lakes around the globe. In fact, the CLM-ORG performance on high-latitude lakes which this study focused on was not the worst. Thus, the method can become much more valuable if the authors can apply this method to some more lakes, especially those deep and large lakes.

Response: Thanks for the comments. We selected one additional lake, Nam Co, located in the Tibetan Plateau (TP) to validate CLM-ORG and CLM-KPP. Nam Co is the largest lake in the central TP with a surface area of about 2,021 km^2 in 2010 (Lei et al., 2013; Zhu et al., 2010). Its maximum depth reaches more than 95 m, and the mean depth is about 40 m (Wang et al., 2009). Thus, we chose this large and deep lake to evaluate our newly coupled model. We have added simulations and analysis for Nam Co to the manuscript. The results are described as follows:

"We validated both CLM-ORG and CLM-KPP with the monthly Moderate Resolution Imaging Spectroradiometer (MODIS) data for Nam Co by conducting 10-km spatial resolution simulations for this lake over the period of 2003 through 2012. We can see that CLM-KPP improved WST simulations averaged over the entire lake (34 model grid cells) when compared with the MODIS data and CLM-ORG simulations (Fig. R1). The RMSE of WST decreased from 4.58 ˚C with CLM-ORG to 2.23 ˚C with CLM-KPP, and the R increased from 0.90 to 0.96 at the same time.

The improved WST simulations with CLM-KPP were closely related to the water mixing simulations with the KPP as discussed in the manuscript. We averaged the K_w^{ORG} and K_w^{KPP} simulations over the water columns with the depth greater than 25 m for Nam Co as shown in Fig. R2, and the total of such columns were 28 out of 34 for this lake. Figure R2 indicated that K_w^{KPP} was slightly smaller than K_w^{ORG} mostly in the mixing layer of the lake over the summer. The difference likely resulted from the enlarged K_w^{ORG} in CLM where this parameter was increased by a factor of 10 when the lake depth was greater than 25 m. In the deeper part of the lake, K_w^{KPP} was much smaller than K_w^{ORG} over the summer due much to K_{ed}'s contribution to K_w^{ORG}. In the spring and fall seasons, K_w^{KPP} was significantly larger than K_w^{ORG} where the buoyancy flux may contribute strongly to K_w^{KPP}. During the winter time when the lake froze, both CLM-KPP and CLM-ORG were set to use K_w^{ORG}. We can see that the most significant improvements in WST for Nam Co occurred during the ice-free seasons when the KPP was activated. Thus, the thermal forcing was an important factor in simulating lake mixing, which needs to be considered in lake models."

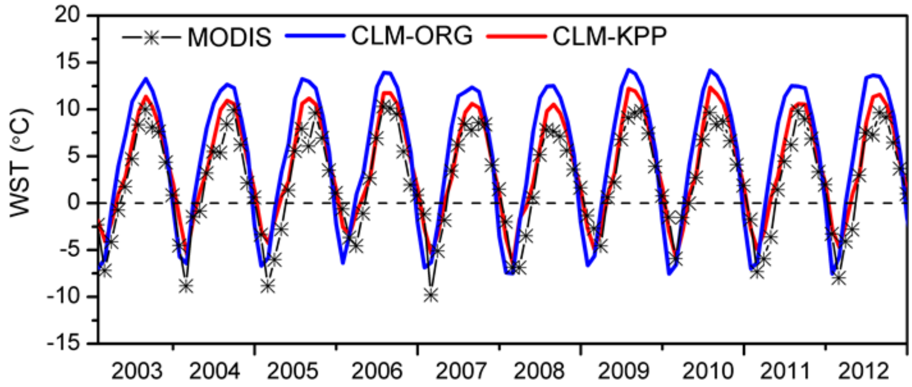

Figure R1. The time series over the period of 2003 through 2012 of monthly WST observations from MODIS (black star line) and simulations with CLM-ORG (blue line) and CLM-KPP (red line) (Unit: ˚C).

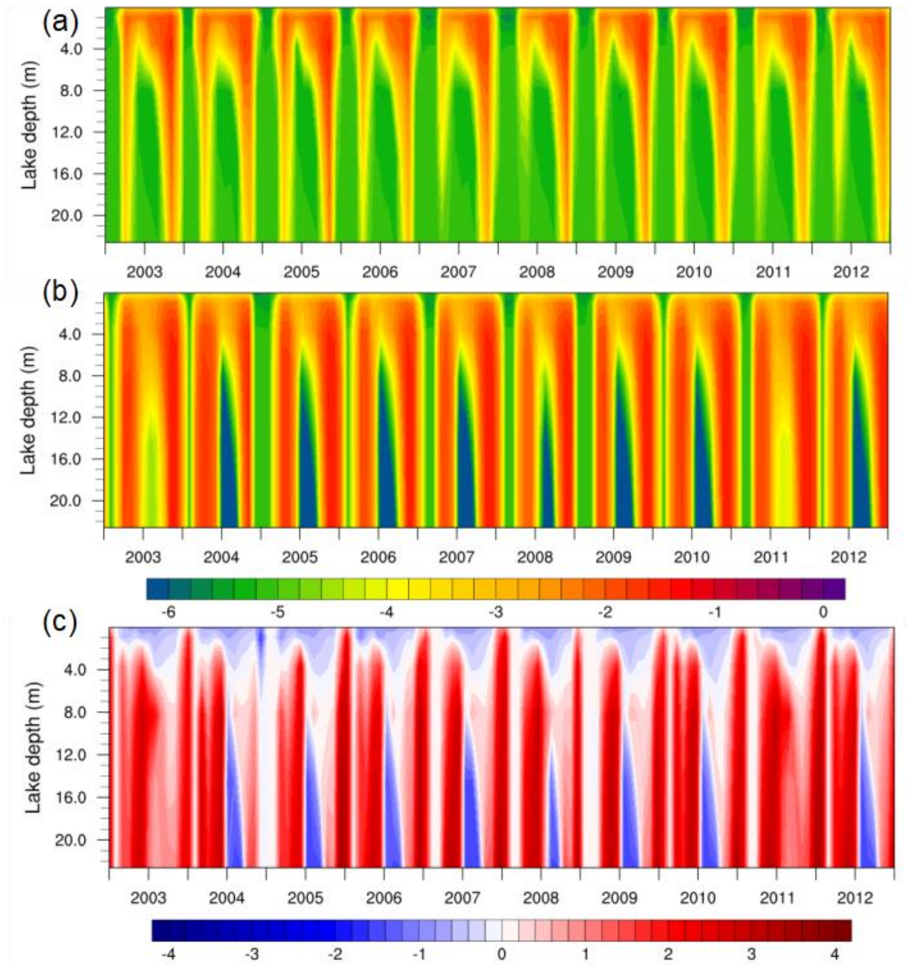

Figure R2. The simulated (a) $\log_{10} \mathrm{K}_{\mathrm{w}}^{\mathrm{ORG}}$ with CLM-ORG, (b) $\log_{10} \mathrm{K}_{\mathrm{w}}^{\mathrm{KPP}}$ with CLM-KPP (Unit: m^2/s) averaged over the water columns with the depth greater than 25 m (28 of 34 grid cells), and (c) the differences between $\log_{10} \mathrm{K}_{\mathrm{w}}^{\mathrm{KPP}}$ and $\log_{10} \mathrm{K}_{\mathrm{w}}^{\mathrm{ORG}}$ ($\log_{10} \mathrm{K}_{\mathrm{w}}^{\mathrm{KPP}} - \log_{10} \mathrm{K}_{\mathrm{w}}^{\mathrm{ORG}}$).

Second, more information about the study lake is needed. Is Fog3 Lake a glacial lake or a thermokarst lake? How was the surface friction velocity derived for this lake? Are the effects of lake fetch and wind shielding considered?

What is the lake's light attenuation coefficient?

Response: Fog3 Lake is a glacial lake. In CLM-ORG, the surface friction velocity w^* (m/s) is calculated as:

$$w^* = 0.0012u_2 \tag{R1}$$

where u_2 is the 2-m wind speed (m/s).

While in CLM-KPP, the surface friction velocity u^* (m/s) is calculated as (Large and Pond, 1982):

$$u^{*2} = \frac{\rho_a}{\rho} C_D U^2 \tag{R2a}$$

$$10^3 C_D = \frac{2.70}{U} + 0.142 + 0.0764U \tag{R2b}$$

where ρ_a and ρ are the air and lake water densities (kg/m^3) respectively, C_D is the drag coefficient and U is the 10-m wind speed (m/s). The effect of the lake fetch was considered in our simulations. In the CLM-ORG, the lake fetch F (m) (Hutchinson, 1957; Wetzel and Likens, 1991) is:

$$F = \begin{Bmatrix} 100, & D < 4 \\ 25D, & D \geq 4 \end{Bmatrix} \tag{R3}$$

where D is the water depth. We also used this function in CLM-KPP.

In this study, wind shielding was not considered. Actually, the Toolik meteorological station providing the wind data is ~1.5 km away from Fog3 Lake, although there are no buildings or trees between the Toolik station and the lake. Thus, the wind shielding effects are not significant. The light extinction coefficient η (m^{-1}) is a function of depth (m) (Hakanson, 1995):

$$\eta = 1.1925D^{-0.424} \tag{R4}$$

In this study, with the lake depth (D) of 20 m for Fog3 Lake, η is about 0.33 m^{-1}.

Third, how are CLM-ORG and CLM-KPP calibrated in this study? I know that CLM-ORG has a water mixing parameter that can be used to increase diffusivity for those deep lakes. Can the parameter values of CLM-KPP described here be applied to other lakes?

Response: Both CLM-ORG and CLM-KPP were not calibrated in this study. Yes, the water mixing parameter in CLM-ORG can be increased to generate stronger water mixing for deep lakes (Gu et al., 2013). Here, we increased the water diffusivity (Eq. (1) in the manuscript) by 10 and 100 times in CLM-ORG and conducted additional simulations for Fog3 Lake as shown in Figs. R3 and R4. We can see that CLM-ORG was still unable to reproduce the observed lake temperatures with the enlarged water diffusivity. Again, we did not adjust any parameters in CLM-KPP when we performed simulations for Fog3 Lake, and the same parameters were applied to the simulations for Nam Co. We see that CLM-KPP more realistically captured the water mixing in Nam Co than CLM-ORG (Figs. R1 and R2).

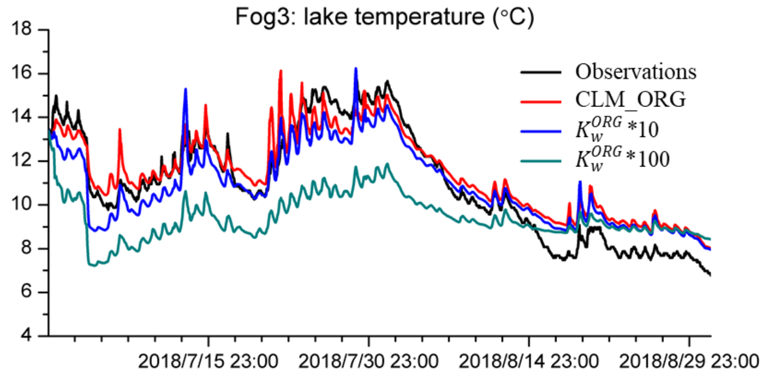

Figure R3. Lake water surface temperature observations (black line), simulations with CLM-ORG (red line), and simulations with K_w^{ORG} multiplied by 10 (blue line) and 100 (green line), respectively.

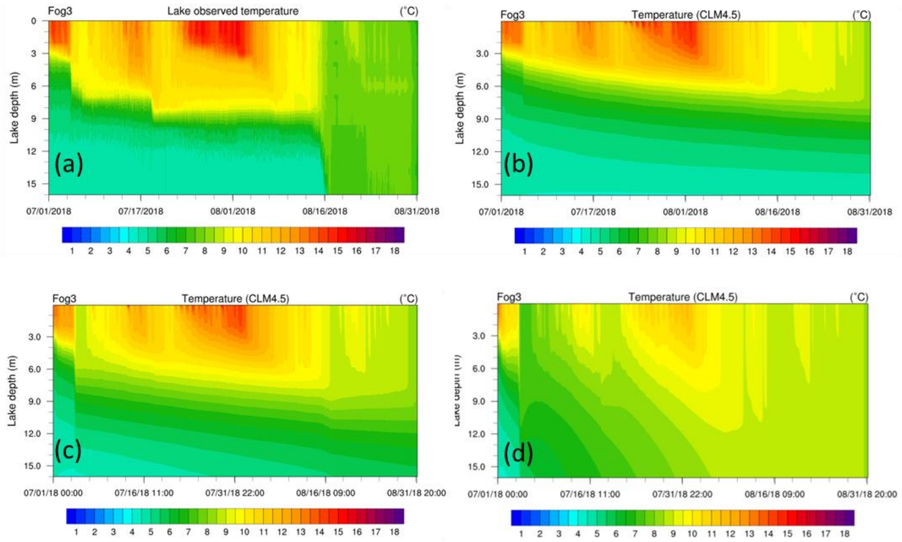

Figure R4. Lake temperature profiles of (a) observations, (b) simulations with CLM-ORG, and simulations with K_w^{ORG} multiplied by (c) 10 and (d) 100.

Forth, I am surprised that the case study did not cover the period of spring water mixing which can have large biogeochemical impacts for high-latitude lakes.

Response: Lake temperature data and some of the atmospheric forcing data for Fog3 Lake are available only for July and August 2018. However, our additional simulations with CLM-ORG and CLM-KPP for Nam Co covered the period of 2003-2012, which included the spring season (Figs. R1 and R2). Our simulations with CLM-KPP were closer to observations than those with CLM-ORG for almost the entire simulation period including the spring seasons.

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