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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Thermal regime, energy budget and lake evaporation at Paiku Co, a deep alpine lake in the central Himalayas" *by* Yanbin Lei et al.

Anonymous Referee #2

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General comments: This paper revealed the energy balance of a deep lake in Tibetan Plateau, one of the least studied regions on earth. Thus in general, the addition of newly obtained data and their analysis is welcomed and could be scientifically significant. However, I have a concern about the accuracy of energy balance determination in this study. Although the authors discuss uncertainty of lake evaporation estimates, I suspect that uncertainty is much larger than their estimate due to the items which authors did not deal with. Details are given in the following specific comments.

Specific comments:

1. Introduction: The authors should explain why lake level and hydrological processes

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in Tibetan Plateau (TP) are important. What kinds of practical and scientific contributions can be made by studying these components over there? Similarly, what are the particular importance of deep lakes TP in comparison with deep lakes in other regions (or other alpine areas)?

2. L76-84. The use of temperature and humidity measured at this location and by this instrument for the purpose of calculating Bowen ratio (Bo) is questionable.

(1) Location

- It is quite possible that this location is outside the internal boundary layer which develops over the lake's surface, particularly when wind direction is from land surface to lake. In order to obtain meaningful Bo values, it is necessary to use measurements within the boundary layer. Note also that Fig.2 should be replaced with a photo showing this location with the actual instrument installed.

- The surface temperature of massive rocks, above which instrument was placed, can be very high during daytime in comparison with air temperature. Thus, the instrument could have been exposed to strong infrared-radiation from rocks. This is a source of measurement errors if instrument does not have a good radiation shield and ventilation (see below).

- Also, given the size of the lake, it is likely that air temperature and humidity near the southern shorelines are different from other parts of the lake.

(2) Instrument

- I have no experience in using a HOBO U12-012 logger, but the manufacturer states that this is designed for indoor use. It seems there is no ventilation of a sensor. Radiation shield (a data logger housing) may not be good enough to prevent effects from direct sunshine in a field condition. These could result in serious measurement errors when it is used outdoors. Authors should explain how (in)accurate their measurements are under their measurement condition and indicate resulting possible errors in flux

estimation.

- The sensor specification states the accuracy of ±0.35°C for temperature and ±2.5% for RH (from10% to 90%). They are not particularly high. The accuracy of the water temperature sensor is ±0.2°C. What would be the resulting accuracy of Bo and fluxes? The final possible error of the estimated fluxes would be due to (1) plus (2).

(3) Independent estimates: if there are wind speed data available, authors may try to apply bulk methods to estimate sensible and latent heat fluxes and compare them with those from the Bowen ratio/energy balance method.

3. L93-94 “For large and deep lake, the components G and AV are small enough to be neglected”. This is not automatic, particularly for AV. Whether or not the statement is valid should depend on relative amount of inflow and storage, and respective energy advection and stored energy. For example, when a huge amount of melted snow near zero degrees discharge into a warmer lake late spring to early summer, this can be a substantial energy advection. To clearly indicate that they can be ignored, authors should give supporting evidence for that (e.g., amount of river discharge, river water temperature, etc.).

4. L103-106. Authors assumed Ts=Tw "because surface water can be mixed quickly by wind in the afternoon" and used Tw for their flux estimation. Please show the data to validate this statement. If no data are available, authors may want to add an argument that a small difference between Ts and Tw does not produce large estimation errors of Bo and fluxes. In general, Ts is not equal to Tw even under windy conditions (see., e.g., Prats et al., Earth Syst. Sci Data, 10, 727-743, 2018).

5. Eq.(5) to calculate heat storage change. What is the accuracy of this estimate? Error sources could be (1) measurement error of water level, (2) accuracy of isobath and water volume estimation, in addition to estimation error of mean water temperature of the lake. I assume water density and heat capacity are missing in this equation. ΔV is the lake volume (and not change), and therefore delta symbol is not necessary. To

make the unit of S in W/m2, I think eq(5) needs to be divided by the lake surface area.

6. L150-158. It is desirable to give comparisons with lakes other than those in TB, to highlight whether or not the thermal structure of lakes in TB is different from those lakes with similar dimensions in other parts of the world.

7. L170-174. "water circulation"; this is an interesting point. Are there any supporting data for the presence of such circulation?

8. L180-183. "large error...if water temperature data collected at the shoreline are used..."; It is also true that some errors can result if only water temperature measured at a central part of the lake is used (and ignore shoreline areas having different temperature) to estimate evaporation of the whole lake.

9. L269 "mean deviation of 1.3 W/m2."; this is a surprisingly small difference. The authors may want to add information on the accuracy of the estimated daily solar radiation by the Himawari-8 satellite data to enhance the credibility of the small difference. By the way, if there are estimates of daily solar radiation at Paiku Co, why not use them for estimating evaporation?

10. L272-L277 "The actual solar radiation at Paiku Co can be considerably overestimated due to the blocking effect of the surrounding mountains around the lake"; I think this type of effects can be estimated by using GIS software such as ArcGIS with DEM as an input.

11. L277-278 "5.4 mm/day.... 3.8 mm/day"; this is a large difference. In fact, the difference (1.6 mm/day) can be translated into 192 mm/(4 months). I suspect that this is closer to actual errors of evaporation estimates than the estimated error given in L295.

12. Chapter 4.2, Again, it is desirable to give comparisons with lakes other than those in TB, to highlight whether or not the thermal structure of lakes in TB is different from those lakes with similar dimensions in other parts of the world.

13. L333-335. "In-situ observations of runoff at the three main rivers indicate that the surface runoff had weak impact on lake level changes.....(Table 3)"; Discharge values in Table 3 are only for short durations. Are those periods during baseflow? What would happen in case of rainfall-runoff events, or snow melting discharge?

14. L373 "Bird B.W. polished the language." I am not familiar with the author's guideline for HESS, but personally, I do not think this is a good reason to make Bird B.W be a co-author.

15. Fig.9; Why there are a large fluctuation when calculation was made with weekly averaged data? Do peaks correspond with week-long sunny periods between rainy events or cloudy conditions?

Technical corrections:

L62: Correct degree sign.

L95: Eq. (2); this equation is confusing. Ra is stated as "downward longwave radiation" in L 97 while Eq. (3) specifies Ra as upward longwave radiation from lake. Downward longwave radiation should be Ra, part of which (0.03Ra=(1-ε)Ra) is reflected by the surface and the surface also emits upward longwave radiation ($\varepsilon\sigma$Tsˆ4). So the final equation of longwave radiation balance should be Ra-(1-ε)Ra+$\varepsilon\sigma$Tsˆ4=εRa+$\varepsilon\sigma$Tsˆ4.

L96: "Rsr.... which is taken as 0.07"; this does not make sense. Could it be 0.07Rs?

L97-98 "Rar...., which is taken as 0.03"; this does not make sense. Could it be 0.03Ra?

L103 "atmospheric emissivity"; the word "atmospheric" is not needed if it indicates water surface emissivity.

Fig.1; Is a black polygon surrounding Paiku Co a watershed divide? Add this information in legend. Show more clearly where incoming rivers are. Also, add information on the elevation of surrounding areas.

Fig.9: Explain what dashed blue lines indicate, please.

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