2-Modeling Lake Titicaca Daily and Monthly Evaporation

Dear reviewer:

Surprisingly the climate warming in this regions today exceeds the average global warming, the evaporation is one the variables that might be altered enormously. Then as it is pointed out the evaporation issue is crucial for this lake, also the interest is to propose a practical models for their implementation, beside the couple of models proposed already by Delclaux et al. (2006), which are dependent on only solar radiation and wind factor data.

According to the previous studies of evaporation in other places there have been found important differences by applying the daily and monthly computation. We think that in order to study the climate change assessment on the models at different time scale, for the case of Titicaca Lake, must be defined the appropriate models at both time scales and also based on our available data. For the first time we obtained high resolution met data for this Lake in the last couple of years. Thus the outputs from climate changes scenarios at any time scale should be able to analysis for this Lake.

As so far we have rewritten the abstract of the paper as it follows:

- **Abstract.** Lake Titicaca is a crucial water resource for the Altiplano, in the central part of the Andean Mountain range, and one of the lakes most affected by climate warming. Since surface evaporation explains most of the lake´s water losses, reliable estimates are paramount for the prediction of global warming impacts on the Lake Titicaca and for the region´s water resources planning and adaptation to climate changes. This study investigated the suitability of fours methods for the assessment of Lake Titicaca´s evaporation at daily and monthly time scales. These methods are: water balance, heat balance, mass transfer and Penman´s equation. Evaporation losses were calculated following the four methods using both, daily meteorological records and their monthly averages. We found that the most reliable method for determining the annual lake evaporation was the heat balance approach, although the Penman equation allows an easier implementation based on generally available meteorological parameters. The main difficulty for the use of the heat balance method is that heat storage changes must be knowing in advance. Since convection from the surface layers is intense during nights resulting in well-mixed top layer every morning, changes in heat storage were estimates from the measured morning surface temperature. The mean annual lake evaporation was for to be1700 mm $year^{-1}$. Monthly evaporation computed using daily and monthly mean between the models results in minor differences.

Specific comments:

P2L13: why are daily observations/estimates necessary? It's not clear from the introduction. Please elaborate.

Answer to P2L13:

- Is correct in the Introduction/objective, abstract and in the discussions chapters it was not highlighted in respect to daily evaporation computation. In fact today is necessary to have the models at time scale for testing climate change scenarios outputs. According the previous studies of evaporation (at daily and month scales) depending on model scale used the results obtained might differentiated as well. This aspect will be elaborate in the introduction part definitely.

  Yes, as it was mentioned in above many empirical models were used at month scale for this lake, but still we have the curiosity on computing at daily scale since for first time we have access to high resolution data, second in order to test the climate changes scenarios we will need to have the models at this scale as well. Finally, we think that the results of evaporation might improve from this perspective.

P6L16: So you don't trust the precipitation data on shore, so why don't you use e.g., remote sensing data? The lake is big enough, I would say.

Answer to P6L16:

- Regarding the quality precipitation data for the Lake we have considered two rain gauges stations; thus it not might very representative for the entire surface area. Farther more the precipitation could the most uncertainty data, in particular in this region because the long-time period it was measured manually. It seems very good idea to use from remote sensing at least for the two research years (2015-2016), we will compute on this way.

P8L27: disadvantage of this method is that a and b are empirical numbers. So you can question if these values found in Russia can be used in Lake Titicaca.

Answer to P8L27:

- Yes, the a (mm $mbar^{-1}$ day^{-1}) and b (mm $mbar^{-1}$ s m^{-1}) parameters are empirical values in the mass transfer equation, and by using the previous values found by Carmouze, the evaporation rate was higher to the rest, even significantly higher. Then we lowered those parameters substantially (from a=0.7 and b=0.30 up to a=0.17 and b=0.155). Definitely, Russian values does not mean that can be used for our case, also Russian values cannot be the minimum limits. Since the actual values found almost is the average between the other existing values maybe we do not need to be redundant.

P8eq11: the surface area A is a function of depth. I assume that the biggest error are caused by this.

Answer to P8eq.11:

- Yes A=f(h), as it was anticipated we used just for A as average value, but since the computation will test by precipitation derived from satellite source, we are able to verify this problem.

P8L20: I don't understand this sentence. Why is daily evaporation not important for the water balance? you can apply the water balance at any time scale you want.

Answer to P8L20:

- Yes it is correct, we can compute at any time scale the water balance, in case of Titicaca Lake due its size the daily evaporation value should affect very little on

the water balance; however the monthly or yearly values might define the lake status. We will analyze more the thinking on the text. However we want to point out that monthly balance modeling is crucial for everything; thus its analysis and accuracy as well.

P14section 5.1: be consistent with the naming of your methods. Now the method 'carmouze' is used, while before it was named mass transfer method. This is confusing for the reader.

Answer to P14section 5.1.

- Ok, the redaction is very easy to correct here.

-P14fig 5: how can you compare evaporation data of two different years? Would be weird if they were the same.

Answer to P14fig 5:

- In the paper we analyzed the full continuous met data gathered during 2015 and 2016 and according to consistent flied campaign. By other hand we could not obtain a good experimental evaporation data (tank evaporation data). I fact we are comparing the methods for each year because we need to be sure that methods and the data work, especially for the monthly values like was anticipated. In the same way that the radiative parameters were compared. All the authors have been show until now only the mean month values or yearly.

P16L10: I think the biggest error is not the water level, but the associated wrong estimation of the surface area...

Answer to P16L10:

- This problem will be correct with new computation of water balance as mentioned already.

-P19L6:?? are you keeping the bowen ratio constant of do you change it day by day? Confusing sentence. Please rewrite.

Answer to P19L6:

- The Bowen ratio changes day by day since we have the observed data at daily.

Minor comments:

-P1L19: ".. using THE heat balance.."
-P1L22: unit of annual evaporation is mm/YEAR
-P3L6,7,8,9,10,11: '-1' should be superscript
-P3L12: unit of annual evaporation is mm/YEAR
-P5L16-18: unit of annual evaporation is mm/YEAR
-P5L24-25: celsius degree symbol is not ok
-P7section3.2.1: add units to all variables.

Answer to minor comments:

- In this regard all the remarks already have been corrected.