Reviewer 1: Dr. Renjie Xia

The authors would like to offer sincere thanks to Dr, Renjie Xia for taking time to carefully review this manuscript and provide insightful comments to improve the quality of the manuscript. Below is a point-by-point response to issues raised in the manuscript.

General Comments

This article is well written, and the topic is interested. Authors did an extensive literature review, and provided a large number of references to validate their work. The conclusions presented in this article are useful.

We greatly thank the reviewer for the compliment.

Specific Comments

(1) Both DYRESM (Dynamics Reservoir Simulation Model) and DYRESM-WQ (Dynamic Reservoir Simulation Model – Water Quality) developed by the Center for Water Research at the University of Western Australia have been extensively calibrated and verified through field work. These models are reliable to use. Authors added an ice and snow model to the DYRESM-WQ, and developed a new model called as DYRESM-WQ-I.

Authors wrote that this resulting model was validated and employed (validated using a long-term (1911-2014) observational dataset, then employed to simulate long-term (1911-2014) ice cover and water temperature in the lake). One question has arisen what is the meaning of "validated" or "employed"? In general, "calibrated" and "verified" are common used in scientific articles. Authors should explain why using "validated" and "employed"? In addition, seems this new model was validated and employed just once by using the same observational dataset. Therefore, another question has arisen that the results obtained from this new model (validated and employed just once) is reliable?

The authors thank the reviewer for pointing out this oversight and confusion in the manuscript. DYRESM-WQ-I was calibrated for Lake Mendota by setting the minimum layer thickness in the model. Other parameters for the hydrodynamic and ice models were chosen from previous literatures. Specifically, for the ice model, it is based heavily on the previously calibrated and validated Mixed Lake with Ice (MLI) model developed by Rogers et al (1995). Alterations to the model are for two-way coupling of the water-column dynamics to the ice model (MLI has only one-way coupling) and the addition of a time-varying sediment heat flux for all horizontal layers wherein the heat flux is dependent on both time-varying sediment temperatures and time-varying lake water temperatures. As the Rogers et al (1995) model has been previously validated through extensive field effort, we did not conduct further field-validation for this study. However, we calibrated the model for the period of 1995-2014. We add a new section, "2.2 Model calibration" and validated compared to observed data for the full simulation period 1911-2014. We have added the following text to improve clarity on model development, calibration, and validation.

P 5, L18-20: *" The ice model is based upon the MLI model of Rogers et al., (1995) with alterations to two-way coupling of the water-column dynamics to the ice model and the addition of time-dependent sediment heat flux for all horizontal layers."*

P7, L21 – P8, L2: "*The model was calibrated for the period 1995-2014 by varying the minimum layer thickness over values ranging from 0.05 m to 0.5 m at 0.025 m intervals. Layer thickness values were evaluated for the least amount of deviation between predicted and observed temperature values for Lake Mendota over the period. Based on this analysis, a minimum layer thickness of 0.125 m was chosen as the best setting to predict water temperature at all depths. Other parameter values in the hydrodynamic and ice cover models were obtained from literature values (Table 1). To evaluate the performance of the model, root-mean square error (RMSE) was used to compare simulated and observed ice cover and water temperature values for the full model period (1911-2014; see Sect. 4.2). Simulated and observed values are compared directly, with the exception of aggregation of water temperature measurements to daily intervals where sub-daily intervals were available.*"

Additionally, a new table, Table 1, has been added to the manuscript to provide parameter values used in the hydrodynamic and ice model portions of DYRESM-WQ-I.

(2) One suggestion: dividing the long-term observational dataset to two groups, then using one for the "validated" purpose, and using another for the "employed" purpose.

Please see the response to comment 1. Specifically, we calibrated the model for the period of 1995-2014. Afterwards, we validated the model for the full simulation period 1911-2014.

(3) Readers might be interested in the long-term 104-year continuous dataset and want to know how many variables observed are included in this dataset. Summarizing a table to show all the observational variables in the dataset will be grateful to these readers.

The authors agree that the observation datasets used for model input and calibration/validation are valuable to readers. Indeed the variables are listed in the subtitles of section 3. Including another table listing datasets in addition to what is included within the text may be repetitive. Instead, we have revised sections of the text to further detail where raw datasets are available and where data adjustments were made to improves the clarity of datasets.

Reviewer 2: Dr. Roman Zurek

The authors would like to thank **Dr. Roman Zurek** for carefully reading the manuscript and providing thoughtful and helpful comments. We have revised the manuscript accordingly and detailed these changes in the point-by-point response below.

Scientific significance: Does the manuscript represent a substantial contribution to scientific progress within the scope of Hydrology and Earth System Sciences (substantial new concepts, ideas, methods, or data)? Yes Scientific quality: Are the scientific approach and applied methods valid? Are the results discussed in an appropriate and balanced way (consideration of related work, including appropriate references)? Yes Presentation quality: Are the scientific results and conclusions presented in a clear, concise, and well-structured way (number and quality of figures/tables, appropriate use of English language)? Yes 1. Does the paper address relevant scientific questions within the scope of HESS? yes 2. Does the paper present novel concepts, ideas, tools, or data? Yes it concern concept and realization 3. Are substantial conclusions reached? Yes 4. Are the scientific methods and assumptions valid and clearly outlined? Yes, very clear 5. Are the results sufficient to support the interpretations and conclusions? Yes 6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? Yes 7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution Yes 8. Does the title clearly reflect the contents of the paper? Yes 9. Does the abstract provide a concise and complete summary? Yes 10. Is the overall presentation well structured and clear? Yes, perfect 11. Is the language fluent and precise? Yes 12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? Yes 13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? Generally is OK, however see comment 14. Are the number and quality of references appropriate? Yes 15. Is the amount and quality of supplementary material appropriate? Yes

We appreciate the positive comments assessed by Dr. Roman Zurek. We address the specific comments raised by the reviewer to improve the quality of the manuscript.

General comments.
To some extent, the discussion develops the chapter "results" and is focused on the examined lakes. In my subjective opinion lack of comparison with similar studies in lakes from another part of the world. I suggest to compare with European lakes with similar latitude For example:
Skowron R. 2009. Changeability of the ice cover on the lakes of northern Poland in the light of climatic changes. Bull Geogr, 1,: 103–124 http://apcz.pl/czasopisma/index.php/BOGPGS/article/viewFile/2312/2296

Marszelewski W., Skowron R. 2006. Ice cover as an indicator of winter air temperature changes case study of the Polish lowland lakes. Hydrol. Sci. J. 41, 336-349 http://www.tandfonline.com/doi/pdf/10.1623/hysj.51.2.336

Choi´nski, A., L. Kolendowicz, J. Pociask-Karteczka, et al., 2010: Changes in lake ice cover on the Morskie Oko Lake in Poland (1971ï ˘A 2007). Adv. Clim. Change Res., 1, doi: 10.3724/SP.J.1248.2010.00071.

Choi´nski A., Ptak M., Strzelczak A. 2013. Areal Variation In Ice Cover Thickness On Lake Morskie Oko (Tatra Mountains). Carpathian Journal of Earth and Environmental Sciences, 8, 3, 97 -102
https://www.researchgate.net/publication/263733557_Areal_variation_in_ice_cover_thickness_on_lake_morskie_oko_Tatra_mountains

We have included these references, of which we were previously unaware. Many thanks for providing the references. We have incorporated comparisons to the earlier studies in European lakes where appropriate in the text.

Pg 14, L7-10: "*These results are much smaller than those for European lakes of similar latitudes (Choiński et al., 2010, 2013; Marszelewski and Skowron, 2006; Skowron, 2009), with changes ranges from 0.20 to 0.60 cm* yr^{-1}*, almost double that of Lake Mendota if the current change per year is extended to change per century*."

Pg 15, L8-16: "*Similar tendencies have been observed at other lakes, which show decreasing ice cover duration from later ice on dates and earlier ice off dates (Choiński et al., 2010, 2013; Marszelewski and Skowron, 2006; Skowron, 2009). However, lakes in near the Great Lakes, North America and Poland have shown larger rates of change over periods of less than a century. For example, Jensen et al. (2007) observed average ice duration decreases of 5.3 days* $decade^{-1}$ *from 1975-2004 in the Great Lakes Region, and Polish lakes had observed changes as large as 0.8 to 0.9 days* $year^{-1}$ *for the peirod 1961-2000 (Marszelewski and Skowron, 2006) and 0.5 to 0.6 days* $year^{-1}$ *from 1956-2005 (Skowron, 2009).*"

Pg 23, L14-16: "*Similarly, lakes in Poland show a considerable statistical relationship between ice cover and the North Atlantic Oscillation winter indexes (Skowron, 2009), indicating that ice cover may be driven by other large oscillations as well.*"

Technical notes

Page 2, Line 11 insert space , 1994 which
This change has been made

Page 9 line 7 : correct
The spacing issue has been corrected.

Page 11, line 15. is: trend of .224, should be 0.334
We have corrected this on Page 12 – Line 11

Fig 2 I suggest to use filled triangle for snow, will be better visible
We have made this change in Figure 2 as suggested.

Page 3, line 13 is Jiang et al. 2010
We change to Jiang et al. 2009
Page 3 line 32, Stefan et al 1996, lack in references

Reference has been added on Page 35 Line 10-13.

Page 4 line 3 and 8 is Schindler et al 1996 lack in ref.
Reference has been added on Page 34 Line 27-30.

Page 5 line 17, is Patterson 1981 lack in ref.
Reference has been added on Page 33 Line 13-14.

Page 6 line 1 is McKay, 1968 in references lack year 1968
Reference has been added on Page 32 Line 37-38.

Page 8 line 10, Rodinov 2006 lack of year in references
Reference has been added on Page 34 Line 9-10.

Page 8 line 16 is Kitchell 1992 im Litereture is Kitchell 2012
The year has been changed to 2012.

Page 9 line 20, is Lathrop et al 1996 in teferences is 1998
The reference has been changed to 1996. See page 32 Line 6

Page 18 line 3, is Lathrop et al. 1996, in literat. Is Lathrop et al 1998
The reference has been changed to 1996. See page 32 Line 6

Page 23 line 13 Stauffer and Armstrong 1986 m in references lack of year
The year has been added.

Page 23 kune 15 is Lee1973 insert space
Inert the space

Page 23 line 18, is Rice 2015 lack in references ther is Rice et al 2014
Change to 2015 see Page 33, Line 32

Page 23 kine 23, is Carpanter et al 2007 lack in references
It should be Carpenter et al. 1992.

Table 2 footnote Lathrop et al 1996 lack in references
The reference has been added on Page 32 Line 4-6.

Over-abound , in excess
Revised.

Lathrop & Carpenter 2011Not cited, Malm et al 1997 not cited in the text, Rodionov 2005
All are removed from the references.

Thank you to the reviewer for pointing out these errors in references and citations. All the above errors in references have been corrected accordingly. Furthermore, we have reviewed the reference list carefully to update other missing or improperly formatted references in the text and reference list.

Links to websites move to footnote
The author guidelines for this journal specify that the use of footnotes should be avoided as much as possible. As result, we keep them in the text in an effort to conform to the journal guidelines.

Remarks to figures
Fig. 2. use line 0.1-0.3 mm, not hairy, Snow symbol (triangle) fill.. Will be visible.
We have changed the fill on the triangle representing snow thickness to make the symbols more visible.

Fig 4.line use to open circles not hairy, minimum 0.1 to 0.3 mm
We have changed the thickness of the lines on the charts to make them more legible.

Reviewer 3: Dr. Homa Kheyrollah Pour

The authors would like to thank **Dr. Homa Kheyrollah Pour** for providing the valuable comments to further improve the quality of the manuscript. We address the comments and detailed these changes in the point-by-point response below.

This manuscript presents a study to demonstrate a long-term change in ice cover and thermal structure of Lake Mendota using a 1-D hydrodynamic-ice model. I have enjoyed reviewing this manuscript and I do believe that it is suitable for publication in a special issue of Hydrological Processes, in terms of its overall content. In general, the authors have made sound intellectual arguments and use an appropriate methodological approach, based on knowledge obtained from previous research studies. In addition, they provide a reasonable interpretation of the results obtained from this study.

We thank the reviewer for the compliments.

General comments:

The author used daily meteorological data to run the DYRESM-WQ-I model, however is mentioned that the model has 1-hr time step at page 6 line 5!

Yes, this is correct. We used a daily timestep for meteorological and inflow/outflow inputs based on the availability of data to complete the study (subdaily data availability was not consistently available for the 100+ year time period). Model output was also at daily intervals. However, the model itself performs calculations at a 1 hour timestep both for the hydrodynamic and ice cover components of the model. This 1 hour timestep was chosen to ensure that change in ice depth is relatively small because the time step is small.

The author used the rain fall and snow fall observations from weather station. Snow accumulation regimes differ significantly not only between but also within the various locations over a lake. Snow depth can be very thin and dense to non-existent on some lakes or lake sections due to the wind. This difficulty in accurately measuring snowfall has to be considered specially when running 1-D models. This can be done by looking at any available in-situ snow observations over lake and calculating the percentage of snow in comparison with the station data. And also it is not clear how the snow density is defined. Are there any in-situ observations available for snow density?

The authors thank the reviewer for this valuable suggestion. We acknowledge that the snow depth is variable both between the meteorological station and the lake and across the lake itself. In-situ snow observations over the lake are generally limited to one location once per year for only a limited subset of the 104 year model period. During the winter 2009-2010, when ice and snow measurements were taken multiple times, snow depth matches well with errors of <1 cm to 7 cm during the year (see Figure 3a). As we only have 49 snow measurements for 104 years of simulation data, adjusting snow amounts by first comparing in-situ observations to station data may not be appropriate. However, we will definitely use this approach to improve model ability during shorter-term studies in the future. Snow density is predicted according to Equation 11 in Rogers et al (1995 - see manuscript reference list). $\rho_s = \rho_n + (\rho_m - \rho_n)\{1 - [\exp(-kd)]\}$. $k = -\ln[(\rho_m - \rho_l)/(\rho_m - \rho_n)]$, ρ_n is the density of fresh snow, ρ_l the density 24 h after falling, ρ_m the maximum density, and d the number of days since the last snowfall. To our knowledge there are no in-situ measurements of snow density for Lake Mendota.

Some specific questions/comments I have about this manuscript are as follows:

Page 2/lines 24-25: “Air temperature, wind speed, and water clarity are important factors driving these lake ecosystem properties”, reference is missing.

The line has been updated as follows to add references: "*Air temperature (Findlay et al., 2001; Lynch et al., 2015), wind speed (Brown et al., 1993; Lynch et al., 2015), and water clarity (Arhonditsis et al., 2004b; Lathrop et al., 1996).*"

Page 2/lines 27-29: “The long-term response of lake ice and water temperature to changing air temperature and wind speed is integral to assessment of the potential impacts of climate change on water quality and ecology of lakes.” It is not clear if the author is talking about the role of lake ice on climate or the response of the lakes on climate. Please be more specific.

We thank the reviewer for pointing out this unclear sentence. The authors are discussing the response of lake ice and water temperature to changes in climate and the corresponding impact of lake ice and water temperature changes on lake ecology. The sentence has been edited for clarity as follows: "*The response of lake ice and water temperature to long-term changes in air temperature and wind speed is integral to assess potential impacts of climate change on lake ecology.*"

Page 8, 3.2 meteorological variables: the location where the meteorological data are collected is not clear and how far it is in comparison with the simulation points.

All data except for solar radiation is obtained from the weather station of the National Climate Data Center (NCDC, NOASS) locate in Madison (MSN) Dane County Regional Airport (Truax Field), which is approximately 4.5 km east of the simulation location. Solar radiation data are obtained from the St. Charles, Illinois weather station, approximately 150 km southeast of Lake Mendota. Section 3.2 has been updated to clarify where the meteorological data were obtained and how far those locations are from the study site, Lake Mendota. New additions are provided in bold, text.

"Meteorological data for the Madison area have been continuously recorded since 1869, however, the station and techniques have changed several times. Robertson (1989) constructed a continuous, homogeneous daily meteorological dataset from 1884 to 1988 by adjusting for changes in site location and observation time, and resultant changes in the surface roughness (e.g. height of surrounding trees and buildings). These data were appended with data from the most recent weather station of the National Climate Data Center (NCDC, NOAA) located in Madison (MSN) Dane County Regional Airport (Truax Field), **approximately 4.5 km east from the simulation location, the same site as that used in 1988. All data except solar radiation can be obtained for Madison (MSN) from http://www.ncdc.noaa.gov/, except solar radiation which can be obtained from http://www.sws.uiuc.edu/warm/weather/ (approximately 150 km southeast of Lake Mendota).** *Since Robertson (1989) adjusted all historical data to that collected in 1988, no adjustments are applied to the recent data except for wind. In 1996, a discontinuity in the wind record was caused by change in observational techniques and sensor locations (McKee et al., 2000). To address the non-climatic changes in wind speed, data from MSN are carefully compared with those collected from the tower of the Atmospheric and Oceanic Science Building at the University of Wisconsin-Madison (http://ginsea.aos.wisc.edu/labs/mendota/index.htm),* **approximately 4 km south of simulation location**. *Hourly data from both sites ($U_{MSN,hourly}$ and $U_{AOS,hourly}$) during 2003–2010 were used to form a 4×12 (four components of wind direction × 12 months) matrix ($K_{4,12}$) of wind correction factors, yielding $U_{AOS,daily} = K_{i,j} \times U_{MSN,daily}$. A comparison of results indicated that the MSN weather station measured a higher magnitude in winds out of the east by 5% and lower magnitude in winds out of the west and south by 30% and 10%, respectively. The adjusted wind data ($=K_{i,j} \times U_{MSN,daily}$) are used in the model simulation. Overall the adjusted wind data show a decline in mean wind velocities of 16% from 1988−93 to 1994−2014) compared to 7% at a nearby weather station with no known observational changes (St. Charles, Illinois; 150 km southeast of Lake Mendota)."*

Page 12/lines 22-26: "Other models including LIMNOS (Vavrus et al. 1996) on Lake Mendota, Wisconsin; MLI (Rogers et al. 1995) on Harmon Lake, British Columbia; and CLIMo (Duguay et al. 2003) on lakes in Barrow, Alaska; Poker Flat, Alaska; and Churchill, Manitoba produced similar errors to Lake Mendota between modeled and observed ice thickness and snow cover". This comparison should be more specific and the authors have to give a range of error.

To address comment, we have revised the writing as follows (see Page 13/line 20-30): *"In comparison, similar discrepancies between modelled and observed ice thickness and snow cover were produced from other models including LIMNOS (Vavrus et al., 1996) on Lake Mendota, Wisconsin with discrepancies of 4−9 cm for ice cover; MLI (Rogers et al., 1995) on Harmon Lake, British Columbia, which had up to 6 cm error for ice cover and 4 cm error for snow cover; and CLIMo (Duguay et al., 2003) on lakes in Barrow, Alaska (differences of 5−6 cm for ice thickness); Poker Flat, Alaska (mean absolute error of 2 cm for ice cover and underestimation of snow - ice thickness of 7 cm); and Churchill, Manitoba (Ice thickness observations were within model values for the snow-free and 100% snow covered scenarios). Duguay et al. (2003) found that variability in snow density and snow accumulation play a significant role in ice thickness, which may account for discrepancies between simulated and observed ice cover thicknesses in our study.."*