Anonymous Referee #2

1. Bosson et al use large words at the beginning regarding what the manuscript is supposed to include. I am sorry to say, the data itself, the presentation of the data and the interpretations are not living up to those promises. At its best, the material reads like an internal report and not a scientific manuscript aimed to advance our understanding of the Arctic hydrologic system.

   Answer: The reviewer uses a condescending tone and makes statements, here and in the following comments (no. 2-8), which give the impression that he/she has not particularly thoroughly read the manuscript. In fact, the only place in the manuscript where we discuss what the manuscript will include is in the introduction (P9274 L3-12 of the original manuscript) where only the formulation "with a high degree of confidence" can be what the reviewer here refers to as "large words". We have in the revised version of the manuscript re-formulated the introduction to better explain the aim of the study as follows:

   "The present study focuses on the short-term (intra-annual) variability of the linked surface and subsurface hydrological flows and processes in an arctic permafrost catchment in western Greenland. For this catchment, we present a new hydrological dataset, as a controlled field experiment carried out within the relatively small catchment area (1.56km^2) over a relatively short investigated time period (1 year). The spatial and temporal investigation resolution, however, is relatively high within this small area and short time period. This dataset resolution, for many relevant hydrological processes, enables quantification of the net cumulative water balance over the investigation period with a relatively high degree of confidence, considering also the links between surface waters and both supra-permafrost and sub-permafrost groundwater, and between the small catchment and its associated lake talik. Even with such an extensive measurement programme, however, some key uncertainties still remain, and a main study aim is to bound and assess these remaining uncertainties in the quantification of main hydrological flows and net water balance of the study area. For this purpose a conceptual model of the relevant hydrological system is constructed, which can also be further used as a basis for modeling of the permafrost hydrology in this area."

2. The organization is poor (methods, results and discussion are mixed between respective section, tables/figures are not numbered in the order they are referenced etc).

   Answer: The revised manuscript is re-organised according to concrete suggestions by other reviewers.
   The heading of Section 2.3 is renamed "Annual water balance calculations". In this section we clearly describe how annual sums of the different water balance components are calculated for the lake and for the surrounding catchment. A figure illustrating the link between equations (1),(2) and (4) is also included in the revised manuscript. Accordingly, the result section is also changed so that it first presents the results of the annual sums of the water balance. Section 3.2 now has the heading "Annual water balance, base case". In the revised version of this section, the results for both the lake and the catchment are presented on the annual basis. We explain how the sum of (Ral+Rs), linking the lake water balance to the catchment water balance, is used in the two equations (2) and (4), and the result for Ral+Rs is given in mm/y, normalized with the lake area and with the catchment area. In section 3.3 of the revised manuscript, the uncertainties in the annual water balance are addressed by studying intra-annual variation of the runoff component, and the heading of section

3.3 is now “Estimation of uncertainty intervals for P, E and (R_{al}+ Rs_{in})”. The previous section 3.4 is deleted and incorporated into the new section 3.3. A new section 3.4 is included and named “Annual water balance, uncertainty cases”. In this section, we describe how the results from the uncertainty analysis of the frozen period only are used to define uncertainty intervals for P, ET and R on an annual basis for the lake and for the catchment of the lake. The old section 3.5 is deleted and incorporated into the new section 3.4.

3. Field measurements or calculations are not described (how did the authors come to the presented SWE values, PET, and sublimation to give some examples).

Answer: In the supplementary material it is described how the snow accumulation and melting (SWE) was calculated by applying a degree-day method to precipitation and air temperature data. In the supplementary material it is also explained that the PET was calculated with the Penman-Monteith equation, a commonly used method to calculate PET. In the revised manuscript under section 2.2.2 “Meteorological data”, it is now also clearly stated that the Penman-Monteith formula was applied and which input data were used. Also, the revised manuscript describes that a degree-day method was used to calculate the SWE

4. The authors keep referring to the Supplement Section for details, but I find that to be a rather poor solution in presenting information that is essential to the manuscript.

Answer: We are presenting an extensive data set in this study covering many different parameters. The manuscript would become too long if all data presentations were to be in the main text; this is why some data are presented as supplementary material.

5. An excessive amount of space is utilized to describe what the paper will be about instead of letting the results speak for themselves (to avoid overselling the product, which is currently a problem). Figures and their units are unclear, terminology is sloppy (lake level and pressure is used as it was the same thing, it is not acknowledged that the active layer thaws throughout the summer etc).

Answer: Figures 1, 2, 6, 7, 8 are updated in the revised manuscript. The updates are based on valuable concrete suggestions from other reviewers. Figure 1 is enlarged to make it easier to see what it contains. Figure 2 is corrected to reflect the structural changes regarding the method and result section above. In Figure 6, SWE and P are added to provide a more informative figure. All numbers in Figure 7 are expressed in mm/y instead of m^3/y. Figure 8 is divided into two sub-figures to make the figure easier to interpret. All units are clearly marked in each figure.

We will go through the terminology in the text in detail such that it will be absolutely clear when the text refers to lake head, lake pressure or lake level.

The thawing and freezing of the active layer is illustrated in Figure 3 and Table 4. In section 2.2.2 “Active layer and lake ice” it is also described that the active layer reaches its maximum in late August-early September.

6. I think the authors are putting too much confidence in their field measurements, including how representative they are for the larger watershed both in space and time (this is just a one yr study).

Answer: The size of the catchment is small, 1.56km^2, and the spatial resolution of measurements within it is relatively high. Fluxes and processes are also measured with relatively high temporal resolution within the one-year investigation period. To our best knowledge, such interactions between soil/groundwater in the active layer, surface water (here in the lake) and groundwater in the sub-permafrost system (here in the talik below the lake) have not previously been quantified by using only locally measured data at such a site itself, rather than e.g. meteorological data from some regional station several kilometres away for the actual site. In addition, locally measured data show that surface processes, such as evapotranspiration and snow dynamics, also govern the head variations in the deeper groundwater system in the talik below the lake.

The focus of this study is on the quantification of intra-annual variation and uncertainties of water levels and fluxes, and other components of the cumulative net water balance over the given investigation period. The aim was not to assess a representative long-term average water balance and its associated flux components. The study addresses how to conceptualize and quantify the main hydrological flows and processes in the catchment during the investigated hydrological year and the uncertainties that still remain even with an extensive measured dataset for such a limited time period; this uncertainty assessment is also important for long-term average conditions, as the uncertainties of each year combine to the total ones over the long-term period. The limitation, relative to long-term average conditions, of this study considering only a period of one year was assessed by relating the local values of precipitation to the long-term average values obtained from the nearby Kangerlussuaq station. In addition, we compare also in the revised manuscript local air- and soil temperature data to corresponding long-term values from the Kangerlussuaq station.

We realize that we in the original manuscript failed in explaining the objective of the presented water balance study. The introduction of the new manuscript is revised as explained in the answer to comment no. 1 above. See also answers to general comments from reviewers 1 and 3.

7. For example, storage in the active layer is solely determined by one soil moisture sensor and basin SWE value from one meteorological station. In fact, I think assumptions like those is a reoccurring problem of the paper. For example, the authors are making a big deal about their mismatch in the different estimations of groundwater flow under the lake during the "frozen period" and spend pages on exploring why that is. I really don't see the point of the "three cases" as that section is not leading to anything more than what is already brought forward, especially since terms are estimated as residuals of previous equations.

Answer: Criticizing the spatial resolution and representativity of the meteorological data in this study is quite extravagant. We have a local meteorological station in a catchment area of only 1.56km^2. The size of the catchment is clearly stated in the manuscript. Many studies do not even have a meteorological station in much larger areas than this one, using instead meteorological data from stations outside their actual study areas. In addition, we have in this study also access and relate local precipitation and air temperature data to the nearby station in Kangerlussuaq, situated approximately 30 km from the TBL catchment.

Section 2.2.2 “Soil moisture data and porosity” further describes that there is a positive storage change in the active layer over the studied hydrological year, and states clearly that the description of the storage change quantification is given in the Supplementary material. The supplementary material also provides the information that 44 TDR sensors are installed in the catchment and used in the calculation of soil moisture storage change. Also, Figure 1 shows the locations of the three clusters of all these TDR sensors spread over the catchment area. The information about this number of soil moisture measurement sites, used when quantifying the storage change in the catchment, is now also added in the main text of the revised manuscript.

8. On top of it all, the authors have done a poor job in referring to existing literature and I think the manuscript could be dramatically improved if they took their time to review (specifically older) publications on permafrost hydrology in general, and lakes and taliks in particular. To conclude, try again. Drop the advertising a few notches, acknowledge past literature and let the data speak for itself in an effort to find what story your field efforts can provide in relation to the existing literature on Arctic hydrology. Perhaps focus on a lake-talik-permafrost theme?

Answer: We do not agree, and resent this condescending tone. We have in this paper referred to the most relevant and recent publications. The present work is not a review paper that has to include all possible papers on arctic hydrology.