Response: We thank the reviewer for taking the time to provide such a thoughtful and thorough review. We greatly appreciate the reviewer's suggestion to provide discussions on the region of subglacial water piracy and setting clear objectives of the study. We have addressed all of your points, and list them alongside your review.

R1: *1. General comments:*

This paper presents numerical experiments on meltwater discharge from tidewater and land-terminating glaciers in the Kongsfjord basin in Svalbard. Meltwater runoff was computed by an energy balance and snow process coupled model, which was previously published by the authors (Pramanik et al., 2018). The results of the previous paper are used in this study to investigate water flow through the glaciers and discharge into the fjord. Two different runoff routing models were applied for the glaciers in the basin to obtain time series of discharge from glacier front. Experimental results are presented in terms of flow paths and drainage basin, as well as time series of glacial discharge (hydrograph) from 2013 to 2016. I enjoyed the readable text and carefully prepared plots. Discharge from tidewater glaciers is drawing attention because of its importance in glacier/ice sheet mass loss and for the interaction of glaciers and the ocean. The authors tackle this problem by applying runoff routing models for a relatively well studied glacier basins in Svalbard, where a long-term proglacial discharge and plume observations are available. Results are interesting and potentially important to understand hydrology of glaciers under a similar setting. A weakness of the study is poorly constrained model parameters. This is critical because validation of the model output is only possible for the land-terminating glacier, where proglacial discharge data are available. Modeled discharge from a tidewater glacier is compared with plume area, but it is insufficient to optimize the model. Because of this shortcoming, it is difficult to assess how realistic the presented results are. Accordingly, discussion of the experimental results is pretty weak and the authors failed to draw important conclusions. In my opinion, more rigorous conclusions are required for a paper published in The Cryosphere. I see the value of the experiment and potential importance of the result, thus encourage the author to perform more careful experiment and writing. In my opinion, the paper will be substantially improved by setting clear objectives of the study, designing experiments to overcome the parameter uncertainties, and analyze experimental results to demonstrate the importance and implication of the study. I list my major concerns below, which are followed by specific comments.

Response: We agree that the parameter choice of simple routing model is very simplistic in nature. To have a robust estimate of discharge, a detail understanding of subglacial hydrology is required with complex modelling and observational data. At present, there is not enough understanding about the subglacial hydrology of the glaciers of this region. Our aim is to simulate discharge at all the outlets of Kongsfjord basin, and with the absence of enough observational subglacial data, we applied a simple approach to give a coarse estimate of discharge. However, if these discharge data are used for daily time period, then we argue that the discharge will have less uncertainty considering the area of the basin and associated delay from the farthest grid cell of the basin.

The runoff produced at the surface takes some time to reach the glacier front which is termed here as delay, and water storage, if any, is considered as negligible in comparison to discharge. Therefore, the sum of discharge and sum of runoff should be equal over a season, however, the discharge hydrograph with and without delay should be different.

We agree that the delay depends on many factors, such as channel shape, bed property, etc., and these are unknown to us. Therefore, we used a single parameter box model to simulate discharge hydrograph. A further approach can try to parameterize the processes governing the delay with a higher-order model, however, that is beyond the scope of this study. Moreover, a higher-order model, such as GlaDS, has more number of parameters, which, in the absence of observation, would add further uncertainty.

Furthermore, we would like to mention that in a recent paper by Mankoff et al., 2020, a similar approach was taken to calculate subglacial drainage delineations of Greenland basins. In that paper, the discharge hydrographs are being simulated for all the outlet glaciers in Greenland, where the transition from runoff to discharge was considered instantaneous. In this paper we took a further measure to incorporate delay to runoff in a coarse way. We argue that with the paucity of observational data, simple and conceptual routing model can serve the purpose of discharge calculation, and the robustness increases with smaller basin and with lower-temporal resolution.

R1: 2. Major concerns:

R1: (1*) Drainage basin analysis: It is interesting to see the drastic change in the drainage basin boundaries, depending on the choice of the parameter "k". I wonder if you can enhance this finding by more detailed presentation and analysis. For example, area of each drainage basin can be plotted against "k", so that quantitative analysis is possible for the impact of "k" on the drainage from each glacier. I am also interested in the mechanism of such migration of the drainage boundary. If you focus the region of "subglacial water piracy" and explain the process in terms of bed/ice geometry, you may be able to generalize such finding for future research. Please also discuss this finding with an attention on surface water production and water transfer from the surface to the bed. Even if a large area in the upper reach switches to another drainage basin, the influence on the glacier discharge is small in case the area is above the percolation zone. because melt is small and do not penetrate to the bed.*

Response: Thank you for your suggestion. We agree that the area of the drainage can be plotted with k, but please note that the area of the drainage basins changes drastically for certain k values (e.g., k = 0.1 and k = 0.4). For rest of the k values the drainage area changes are very less (~ $2km^2$) to be captured in a plot. Therefore, instead of showing it in a figure, we presented the areas in table (Table A1.)

It is a good point to include a discussion on the region of subglacial water piracy (we would term it as the switching zone). We would conduct a comprehensive analysis of this switching zone. In the revised manuscript, we will make a separate section of switching zone in the discussion where we would discuss about the areas of switching zone and provide how possible changes occurring in this area would lead to changes in subglacial drainage delineations.

It is a fact that if the area is above percolation zone, the water piracy would have smaller effect. In this study, the area where the switching occurs is situated in the upper ablation zone of the glaciers (Line 217-221). Therefore, we mentioned that the water piracy would affect discharge in these two outlets (KRB and KNG) only in peak summer and not in early summer/late autumn.

R1: (2*) Discharge hydrograph: I understand that obtaining a hydrograph is an important goal of this study. The reconstruction of hydrograph is successful for the land terminating glacier (Fig. 5). In contrast, results for tidewater glaciers are not reliable. It is not clear how parameters were tuned for the tidewater glaciers and the validation of the results is not convincing (Fig. 4). Further, parameter settings are very simple, as represented by "k" assumed as uniform in time and space. Therefore, hydrographs for tidewater glaciers are questionable*, *and uncertainty is unclear. My suggestion is to perform sensitivity tests and evaluate the uncertainties in the results. By taking various values of k, alpha, and water speed, uncertainty can be evaluated for the discharge and presented as a band in Figs 4 and 5. Please also discuss Fig. 4 in terms of agreement between the discharge and plume area. Frankly speaking, I do not see "agreement" in the plot.*

Response: In the absence of any discharge measurement of tidewater glaciers, we assumed plume as proxy to discharge. We agree that this assumption is also crude as many factors affects plume area, however, one major controlling factor of plume emergence is subglacial discharge. Here, we tried to match the high-frequency of plume area signal with the high-frequency of discharge hydrograph for different alpha/water speed, and we optimized the values from there (Normalized cross correlation).

We agree that it is difficult to optimize the wave speed and many of the wave speed gives similar results. Therefore, instead of finding one single wave speed value, we will use the range of prescribed uniform wave speed and presented the discharge hydrograph as a band, instead of a single line.

For k sensitivities, we did Monte-Carlo simulations with randomly varying k value spatially. For different k values, we only can find certain drainage basin changes between Holtedahlfonna and Isachsenfonna. Therefore, uncertainties in k values would raise only two possibilities, which we discussed (L205-210).

R1: (3) *Model parameters: Parameters uniformly distributed in space and time are very crude assumptions. Significant spatial variations are expected for "k", and it changes over a year particularly in the ablation area. Water flow through a glacier consists of complex processes, thus speed of water movement varies in time and space. Moreover, processes involved in water movement after runoff is given by the melt-snow model is not very clear. Do you assume water drains straight down to the bed? I believe the time required for such process is highly uncertain and variable. Taking all these uncertainties into consideration is not possible, thus some degree of simplification and assumptions are necessary for this study. Nevertheless, I think the treatment of the parameters is too simplistic. In fact, a large portion of Discussion is allocated to describe such short comings. I encourage the authors to perform sensitivity test and provide more rigorous discussion on the model uncertainty.*

Response: We agree that the assumption of uniform distribution of model parameters is crude assumptions, and there is significant variations. In the manuscript, we mentioned that k varies spatially and temporally. To better address this, we conducted rigorous sensitivity analysis (Appendix L356-374). We varied k randomly for 10000 Monte-Carlo runs and calculated subglacial drainage delineations and discussed our findings (Appendix L365-369).

The energy-balance model calculates runoff, that is melt water reaching snow-ice interface after percolation. Yes, here we assume that the runoff instantly reaches bed without any time-delay.

We also believe that there are some number of uncertainties, however, it is not possible to take all those uncertainties into consideration. For subglacial hydrology, we have conducted detailed sensitivity tests to provide a robust estimate. We agree that the treatment of wave speed /alpha parameter in the simple routing model is simplistic in nature. We would like to point out that there is no observational data available from subglacial environment and the use of multiple parameters would further increase the uncertainty of the results. Basically, here we considered that the input (runoff) and output (discharge) is constant and the in between process is a black box which is parameterized with a single parameter. Our simple routing model is apparently a single parameter box model of subglacial water transport without any storage.

We agree that with this approach it is not appropriate to optimize the parameter for tidewater glaciers. Instead, we will calculate the discharge hydrograph for a range of water speed values taken from (Cowton et al., 2013, Slater et al., 2017) provide the discharge hydrograph for tidewater glaciers as a band. A preliminary figure of discharge hydrograph for Kronebreen is provided here (Fig. Res1).

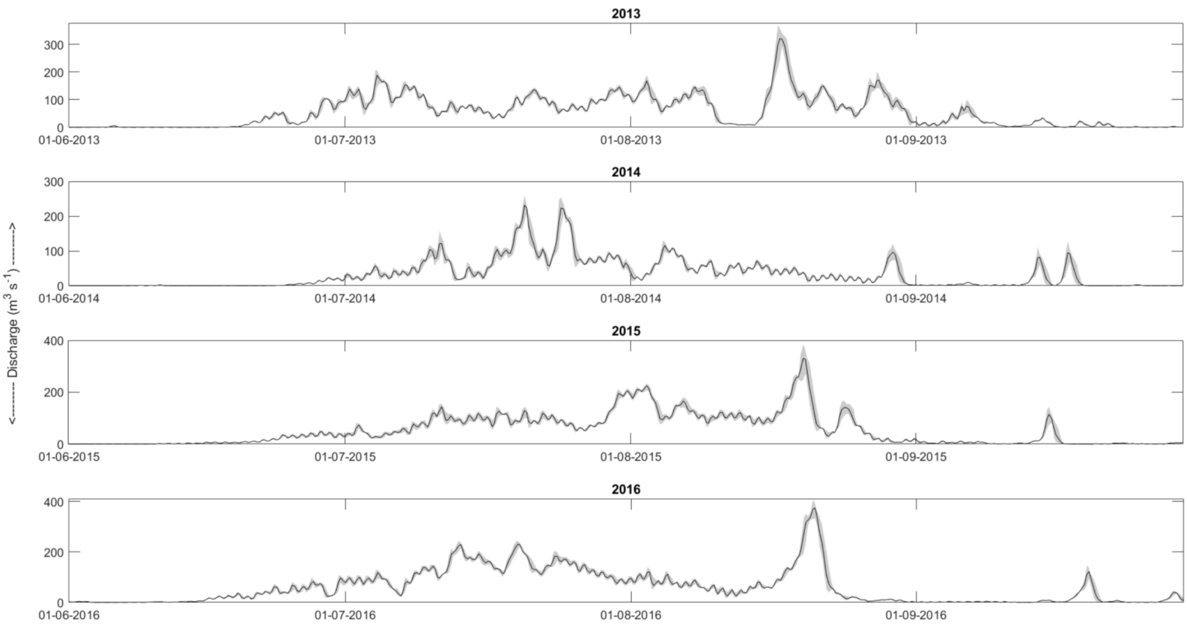

Fig. Res1. Discharge hydrograph for Kronebreen.

Furthermore, we will conduct sensitivity analysis in the switching zone and incorporate that with the routing model to provide discharge hydrograph as a band.

R1: (4) *Objective of the study: My question that forms the background of the comments listed above is "what is the objective of the study?". The abstract suggests "delay in discharge" is the main point of the study (line 2). In the end of Introduction, "drainage delineations" and "subglacial network" are raised as the purpose of the modeling (Line 49). Judging from the presented result, delineation of the drainage basin is worth to highlight. However, I am not sure if the study achieved accurate quantification of* *the delay (Fig. 3b) and what is new about the subglacial network. My suggestion is to define clear study goals. Experimental design, data analysis and presentation should be optimized to achieve them. It is not bad idea to place the focus on the subglacial drainage basin (Fig. 2) and hydrograph (Figs 4 and 5). Setting clear goals of the experiment should guide you.*

Response: The main objective of the study is to calculate discharge hydrograph at all the outlets of Kongsfjord basin. To understand water routing of tidewater glaciers, we conducted subglacial hydrology analysis. We will rewrite the introduction with a focus on subglacial drainage basin and hydrograph.