Authors' response and minor revisions on **"Sensitivity of subglacial drainage to water supply distribution at the Kongsfjord basin, Svalbard"**

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The Cryosphere Discuss., https://doi.org/10.5194/tc-2020-319, 2020

Authors' response to Referee #2

We thank Christine Dow for her helpful suggestions (shown in bold), which we implemented in the new version of the manuscript. We believe that the manuscript has considerably gained in quality and in readability thanks to her thorough review.

I would like to thank the authors for their adjustment of their manuscript and study in response to my review. Using the lower sheet conductivity makes the system look a lot more realistic and so I have much more faith in the outputs being produced. Again, including a spin-up year also helps with output validity. The results and analysis are well presented and are interesting for analysis of Svalbard Glaciers compared to lower latitude glaciers.

I have no major comments and my points below are primarily suggestions for tightening the language for clarity.

Language suggestions

9 – 'modulates ice velocity'.

16 – 'which instead is controlled…'

17 – 'which we attribute to small surface gradients'

18 – 'The findings of our study are potentially applicable to most Svalbard…'

31 – 'been found to be concurrent'

49 – Perhaps 'in reality' rather than 'In nature'. And 'usually is a result of water accumulation over a catchment on the glacier surface'.

53 – also by fractures (in addition to englacial conduits)

92 – 'nunataks are present in the lower parts' rather than 'peak through'

94 – 'ice thickens to a maximum of 740m'

109 – put 'measured in 2012' into the brackets with the reference as otherwise it suggests that the maximum speed was in 2012 and it has slowed since.

146 – 'drainage system was achieved'

152 – 'associated with'

155 – 'we apply the Glacier'

164 – what is the value of that uniform basal melt rate you apply?

170 – 'we direct readers'

184 – 'values different from Werder et al (2013)' Other literature discussing GlaDS uses these values.

185 – 'below the channel'

205 – suggest you replace 'supraglacial hydrology' with 'supraglacial drainage network'

222 – 'associated with'

237 – 'catchments are also adjusted in order to'

242 – 'analysis was carried out'. Check rest of paragraph/manuscript for correct tenses.

274 – 'different sizes of surface area contributing water'

302 – 'this figure' still confusing. Delete 'supports model results for basal water pressure (Fig 3 and 4) an' so it reads 'This figures shows that, at…' Otherwise it is redundant as you're discussing the same model outputs.

305 – 'typically approaches overburden pressure'

308 – 'Over the annual period'

309 – 'recurrent pattern in all seasons is'

401 – 'However, results from this experiment'

410 – 'less' instead of 'poorer'

530 – 'less water supply to their beds compared to lower latitude glaciers'.

533 – last sentence needs work. Instead of 'standard configuration' how about contrary to what would be expected in Greenland outlet or Alpine glaciers.

Figure 7 caption 'subglacial channel distribution'

Response to all previous suggestions: done.

<u>Other suggestions/questions</u>

67 – 'distributed supply rates' is confusing

Response: We removed the words 'distributed' (confusing) and 'calibrated' (not relevant), and added 'gridded' to convey that the input is spatially distributed.

76 – '75% is currently ice-covered'

Response: We replaced 'glacierised' with 'glacier-covered'.

107 – this point about temperate ice is important as it raises the question of where it might not be temperate at the bed. It would be good to briefly expand on this, perhaps in the discussion.

Response: We replaced the part "(...) which indicates that the glacier base is temperate" with "which is consistent with the finding of widespread temperate basal conditions at several glaciers in the region (Björnsson et al., 1996; Sevestre et al., 2015)".

235 – not directly from Fig 2c. What were they specifically identified from? The supraglacial drainage network and…?

Response: The sentence was changed to "These moulins were identified from the modelled supraglacial drainage network (Fig. 2(c)) and the observed crevasses (Fig. 2(d)); more specifically, we added a moulin wherever a supraglacial stream crosses the upper boundary of a crevassed area".

346 – how does the Praminik hydrological analysis affect your confidence in your outputs vs the observations by How et al and Everett et al? Does the Praminik study back up or counter your GlaDS results and why?

Response: The study by Pramanik et al. (2020) mainly focuses on the relative differences in subglacial discharge between Kongsbreen and Kronebreen; differences between Kronebreen North and Kronebreen South are barely mentioned. Therefore, we decided to remove this reference from our manuscript.

The study by How et al. (2017) focuses on Kronebreen only. Their observations indicate that the north-side plume is larger and temporally more stable than the south-side plume; however, they mention that the south-side plume was difficult to measure. Therefore, for the south-side outlet, comparing our model results to their observations remains inconclusive. For the north-side outlet, the observed stability of the plume indicates the existence of a persistent drainage pathway. This could presumably be due to a canal incised into the sediment (Walder and Fowler, 1994), a mechanism that is not included in our model, as mentioned in Sect. 5.3 and Sect. 5.4.

We changed that part to: "This is in disagreement with observations that suggest the north-side outlet has larger and more temporally stable plume activity than the south-side outlet (How et al., 2017; Everett et al., (2018)). While there are geometrical challenges with reliably measuring the south-side plumes area from time-lapse photography (How et al., 2017), the observed stability of the north-side plumes clearly indicates the existence of a persistent drainage pathway that is not captured by our model. This subglacial pathway could presumably exist in the form a permanent canal incised into the sediment (Walder and Fowler, 1994), a mechanism that is not included in GlaDS (as described in Sect. 5.4)".

351 – I'm not sure how this is implied? Can you see evidence of that in your model results?

Response: The sentence was indeed confusing, therefore we changed it to "In late August, channelized discharge in Experiments 1–3–4 reaches its peak, whereas in Experiment 2 the channel network is already collapsing in the regions that receive less water input".

In fact, upon closer inspection of our model results, we see that, in Experiment 2, the channelized drainage system systematically collapses sooner than in Experiments 1–3–4.

384 – how rapid is the closure?

Response: 'rapid' was changed to 'gradual'. The following sentence gives an approximate idea of how fast the channels close, by mentioning "at the glacier termini channels persist until late October".

443 – 'channelization occurs only with high pressurisation'. I'm not sure that follows – you also have channelization when you applied your previous higher sheet conductivity with overall much lower pressure levels.

Response: Even in the initial simulations (with higher sheet conductivity), channelization coincided with high water pressures. Indeed, although domain-wide averaged pressures were lower in the initial simulations (Fig. 3), local pressures were high during the melt season. This is clearly visible in Fig. 4(i) (version 1 of the manuscript), which shows water pressures between 70–100 % of ice overburden pressure in July in the ablation zone, and especially high in the regions where channels opened. Fig. 4(i) shows pressures for Experiment 1, which yields higher pressures overall; however, Fig. 4(j, k, l) show that, in the ablation zone, pressure biases between Experiments 2, 3, 4 and Experiment 1 are close to zero, indicating that in all four experiments water pressures are high in this part of the domain.