

Interactive comment on “Role of discrete recharge from the supraglacial drainage system for modelling of subglacial conduits pattern of Svalbard polythermal glaciers” by Léo Decaux et al.

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This paper looks at the relationship between surface water inputs and subglacial drainage networks, an important topic that previously has received relatively little attention. I especially like the careful mapping of surface drainage networks and the identification of moulins and other water input points, and the use of these data as inputs for the subglacial water routing model. The paper thus has the potential to be a very useful addition to the literature.

C1

However, the paper needs a lot of work before it is ready for publication. Referee 1 has made specific recommendations for tightening up the paper structure, with which I agree. These recommendations will help to create a clearer logical progression from observations to analysis, followed by validation of results and interpretation. This will clarify the aims, results and conclusions of the paper, increasing its clarity and impact. I also agree with Referee 1 that the language requires thorough checking throughout. The grammar, spelling and sentence structure all need careful revision, ideally with the help of a native English speaker. I don't know how 'conduit' came to be spelled 'conduct' throughout the paper, but the fact that this fundamental term came to be misspelled in a paper about glacier hydrology highlights the extent of the problem.

For the most part, the methods are sound and the assumptions reasonable. One of the assumptions, however, is highly questionable with some implications for the reliability of the results. On p. 4, line 3 and following, it is stated: "In the accumulation area temperate ice and firn are present, allowing water percolation through the glacier body..." Using this assumption, the entire upper part of Hansbreen is defined as a WIA (p. 6, line 23; p. 9, line 28). Temperate ice was considered to be permeable by some early authors (e.g. Nye and Frank, 1973), but this is no longer the accepted view (see Fountain and Walder, 1998). The paper by Lliboutry (1971: J Glac 10, 15-29) is well worth reading on this topic. He provides detailed observational evidence and theoretical considerations that show that bulk temperate ice cannot be permeable. These considerations thus invalidate the assumption that water can directly access the bed wherever temperate ice occurs through the whole glacier thickness (such as upper Hansbreen). Instead, firn aquifers are perched above essentially impermeable ice, with the transition occurring at about 30 m depth in the European Alps. Thus inclusion of areas of temperate ice as WIAs (Fig. 3a) is thus not justified. The WIA on Hansbreen should be redrawn omitting the temperate ice zone, and the model re-run.

Independent validation of the model results is of course difficult, given that most of the drainage system below the glaciers remains unobserved. So the location of outflow

C2

points (portals and plumes) is crucial. At present, this important information is not prominent enough in the text. It should be clearly flagged up as the key test of model output, ideally in a separate subsection labelled 'Model Validation'. The location of meltwater portals and upwellings should be plotted on Figs 7 & 8, so the reader can clearly compare the predicted conduit locations with known efflux points. It is also worth noting that a similar model to the one used by the authors was successful at predicting the location of plumes in front of the tidewater glacier Kronebreen (How et al., 2017: The Cryosphere), and also indicates that the K value varies through the melt season. The fact that Scenario (5), $K = 0.85$ represents subglacial channels observed at Crystal and Bird Brain Caves cannot be regarded as model validation. The modelled channels appear because the caves are specified as water influx points. The existence of subglacial channels extending from moulins at these locations is certainly worth highlighting, but this ought to be early in the paper - perhaps in Section 3.2 where the observational data are introduced.

Figures 7 & 8 are very interesting, but their impact can be greatly increased by simply changing the arrangement of the panels. At present, it is very difficult to assess the result and involves much tiresome switching back and forth between caption and panels. Instead, the panels should be arranged so that the two columns show Scenarios 2 & 5, and the three rows show $K = 1, 0.85$ & 0 . This will immediately allow readers to see how the water input and pressure assumptions influence the results.

On p. 8, line 9: the possibility is mentioned that additional water might be released from winter/spring storage in the snowpack. What about the opposite possibility? i.e. how much of the calculated melt might be retained in snow/firn? Does the model simply assume that all meltwater will enter supraglacial/subglacial transport, with zero surface storage? This issue is related to the erroneous attribution of the whole accumulation area of Hansbreen as a WIA. If meltwater in this zone is retained in the snowpack, instead of being immediately transferred to the bed, then this will significantly reduce the modelled water inputs to the bed possibly with major implications for the results.

C3

In summary, this is an interesting paper with a lot of potential. I look forward to seeing a revised version that maximises the impact of the results.

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C4