

Review of Dow et al. Manuscript

This manuscript addresses important and interesting questions surrounding the interaction of Antarctic subglacial lakes with the hydrologic system. The authors are the first to apply a 2D hydrology model such as the GlaDS one here to a synthetic subglacial lake system.

The work presented in this paper is novel and interesting, and in my opinion should be published after a few revisions are made. In particular, I found that on first reading the paper was lacking in a clear motivation/aim/scientific questions it was trying to answer. It was only on second reading that things became more clear and I thought the paper really had good purpose. I think, therefore, that the authors need to work on improving the introduction and motivation. The summary at the end of 6.4 and in the conclusions are very good, and while you don't want to give the results away at the start of the paper, you do want to lay out the questions that you then have answers to.

With this in mind, I would add a short paragraph at the end of the introduction summarising more explicitly what you aim to address with the model ('behaviour and staility of subglacial lakes' is quite vague). Furthermore, explicitly state 'In section 2 we give a brief summary of the model before describing the model setup and configuration in section 3. etc etc.' This will also help make clear to the reader that you just describe results that the model produces in section 4 and only then disuss their *relevance* and application in section 5.

Comments

- **Abstract, line 5** You don't actually really get as far as the impact of the lakes on ice stream dynamics. So I wouldn't write this in the abstract...
- **Abstract and throughout** I am not sure of your use of the word 'funneled' throughout the manuscript. Not a word conventionally used to describe water flow beneath ice sheets. Use 'drawn down/in' perhaps, as you're really referring to the water flowing down gradients in hydraulic potential. Funneled, to me, suggests something only based on bed slope.
- **Abstract line 11** Flux of water 'through' the ice stream... water is flowing at the bed. Using 'through' implies within the ice. So change to 'at the bed of' or 'beneath'
- **Abstract line 12** Delete 'too'
- **Abstract** I find the middle section of the abstract a bit dry and long-winded. Cut down to only what is absolutely necessary. e.g. Line 14 re-write 'In turn, this drainage mechanism causes high water pressures 50km downstream of the lake' (no need for first or last part of sentence in the abstract).
- **6547, line 1** 'has been increasingly' is confusion of tenses (has implies past, and increasingly implies present).
- **6547, line 6-7** Don't use subclauses like this unless have to, as ruins the flow. Re-write 'In the case of Byrd Glacier..., the drainage of lakes *has* been found to cause... '
- **6547, line 8-11** Long sentence with no punctuation- not easy to read.

- **6547, line 12-15** Numerical models are also used to assess the impact of hydrology on formation of lakes (i.e. the other way round). Maybe change ‘impact’ to ‘feedbacks between hydrology and lake formation’.
- **6547, line 18-end** Nice summary of others’ work.
- **6548, line 1** ‘Here’ is a weak start to a sentence. Perhaps ‘In this manuscript’.
- **section 2** Nice summary of model.
- **6550, line 5-9** Long sentence. Split into 2.
- **6550, line 11- 17** Can you justify these values of surface slope and radius slightly more, since they are not included in the sensitivity study?
- **6551, line 10 - 13** Have you said mesh details for first topography? Assuming 780m in ice stream and 1500m upper catchment. State explicitly.
- **6552, line 11** Change ‘funnelled’. ‘Incoming water from upstream’ would seem to me to be a better description. ‘hydraulic gradient in the ice stream’ also isn’t a particularly good description- I presume you mean the the hydraulic gradient *at the bed* of the ice stream isn’t large enough (due to the surface slope of the ice stream not being large enough). Re-write this sentence. The rest of this paragraph provides a very nice clear and concise description.
- **Figure 3** Nice figure. Why the different coloured boxes around a and b? Only adds confusion introducing more colours, so if no meaning just change both of these to black. Same for fig 4.
- **6552, line 17** ‘an area’ change to ‘an area of the domain’.
- **6553, line 11** I find the use of the phrase ‘ramping up’ throughout the paper slightly too informal. Change to ‘...then increasing the water input...’
- **6553, line 13** This *change* is not explicitly shown in Figure 4. Say ‘The overdeepening does alter the time of pressure waves... (compare Fig 4a,b with Fig 3a,b).
- **6553, line 14** insert comma after ‘however’.
- **6553, line 17-19** Very long-winded first sentence, difficult to take in a main point. Perhaps use a semicolon to split it up? ‘A lake is able to form in the overdeepening due to the altered hydraulic gradient from the pressure waves; the hydrological system is not able to adjust rapidly enough to the increased water flux.’
- **6553, line 22** ‘a threshold size’- what exactly do you mean by that?
- **6553, line 24-25** Describe in sequence of events. i.e. ‘...when another pressure wave passes, changing the hydraulic potential and driving more water into the overdeepening’.
- **Figure 6** V nice.
- **6554, line 11** Change to ‘as illustrated by the lake depth plot in Figure 5’.
- **Fig 7** Legend in b being horizontal is slightly confusing at first glance as continuous and no spaces between each colour. Better to just keep vertical and overlap with first part of graph?
- **6555, line 6** Delete ‘we found that’. Unnecessary and don’t want to many uses of ‘we’.

- **6555, line 12** Don't start sentence with 'also'. 'Furthermore' instead?
- **6556, line 4** replace comma with semicolon.
- **Section 5** Nice. A clear, concise summary of the sensitivity tests.
- **6556, line 11-12** 'to some extent' interrupts the sentence. Remove. Also add in some citations of work studying these.
- **6556, line 12-22** Very nice summary.
- **6556, section 6.1** You are repeating what you have just said at the start of this section. I would add your comment about order or magnitude difference in water input to the summary at the start of section 6 and start this section around line 5. Or at the very least get rid of the repetition in the first sentence.
- **6557, line 11, 22** 'Funneling' change to 'draw in'??
- **6557, line 14-15** I think it's decidedly uncomfortable that you reach this stage of the manuscript and state that there is 'strong evidence that this situation does occur in reality' without having discussed at all how actually this might not be best hydrology model (e.g. deformable sediment- much more evidence out there for this than for any channels at all). I know later you do justify this briefly (start of 6.4) but a bit more detail would be good earlier in the paper (even in intro or model description). I'm not saying it takes away from the worth of the work at all, but does deserve discussion.
- **6557, line 25** 'followed by' doesn't work well in sentence here. Change to '...system, before faster water flow then results in temporary channel growth, moving the excess...'
- **6557, line 26** Change to 'there is a resultant close...'
- **6558, line 4-8** Long sentence. Split into two - '...Canada. These are driven by...'. Alter next sentence slightly as well e.g. 'The oscillations lasted over a period of days, as opposed to the years in our model of Antarctic ice streams',
- **6558, line 14.** Didn't read as a complete sentence on first reading. Switch order so subject right at start. 'Surging glaciers provide further evidence of pressure waves'.
- **6558, line 21-22** change to 'than we suggest might occur in an Antarctic system'
- **6559, section 6.2** Nice comparison with jokulhault model.
- **6559, line 23-24** Another unnecessary subclause in sentence. Re-write as '...demonstrates that the lake does not drain without the growth and shrinkage of channels'
- **6559, line 26-27** '...his model demonstrates...'
- **6559, line 28** Change 'controlled' to 'control' and 'did not' to 'do not'.
- **6560, line 1** Change 'the flood characteristics' to 'these flood characteristics...' since you have just been describing them.
- **6560, line 3** 'As described' unnecessary.
- **6561, line 11** change to 'allowed throughflow of all water'.
- **6561, line 5-20** Nice comparison with Carter work.

- **6562, line 14-17** Long sentence. Split into two.
- **6563, line 23** A channel doesn't 'obtain' a size. Change wording e.g. reach, grow to.
- **6563, line 2** 'funneled' change to 'drawn down/in'
- **6563, line 6-10** Don't start sentence with 'also' and split this long sentence into two.
- **6563, line 16-19** bad sentence structure. change. maybe to 'has limitations due to its simplified nature. For example, it does not incorporate...'
- **6563, line 19** Comma after however.
- **6563, line 22-27** THIS IS A KEY POINT that needs acknowledged. Please give it a bit more emphasis and also mention it earlier in the paper when you introduce model.
- **6564, line 17** Change to 'our model' rather than 'our hydrological model' Since what you describe would require a coupled model of both hydrological type and the ice.
- **6564, line 24** Re-structure sentence. '...remove the pressure waves; it might instead...'
- **6565, lines 1-5** Careful here. You have not actually applied it to Antarctic lakes. Make clear synthetic situation, trying to simulate a situation comparable to Antarctic lakes. You should outline something similar to this in the introduction too so that the work as the purpose summarised here from the start.
- **Section 7** Great summary. Perhaps you could also add a paragraph in about future work. Do you plan to implement this model over a real domain/ include some ice dynamics/include ice flexure etc in the foreseeable future?