

# Author response to editor's report on "Observed and modeled moulin heads in the Pâkitsoq region of Greenland suggest subglacial channel network effects"

**We thank the editor for their time and comments on the paper and review.  
The authors' replies are in bold blue**

Editors report for Trunz et al. MouSh paper.

Dear authors,

Thank you for your thorough response to the revisions. Both reviewers agree that the paper is of good scientific merit, although one is more critical of the overall study design. On reading your response and revision, I think there is opportunity to satisfy both reviewers and ensure your results are publishable by slightly changing the narrative of the paper.

The paper is presented as a generalised study of moulin processes, using (highly valuable and hard won!) field data to validate your modelling experiment. However, the moulin monitored in the field is actually pretty small in the context of Greenland moulins. I think that the study would be more applicable, and acceptable to Reviewer 2 if you can make it clearer in the text that this is likely a small moulin that feeds a lower order subglacial channel, that may in turn feed into the wider network. I think this would address some of the difficulties that Reviewer 2 has with the study – it is representative of a certain aspect of the subglacial drainage system, but is not what we would generally think of when visualising the surface-subsurface connectivity for the main trunk of the drainage system. Your conceptual model figure is really valuable to illustrate this, and you do acknowledge it within the text already, but I think putting this understanding up front would be beneficial. The study is not aiming to represent moulin processes generally, but to understand moulin evolution in a small, upper catchment that feeds a larger subglacial network. This would then tally with the high subglacial base flow necessary to match your model results with the field data.

I disagree with Reviewer 2 that the study is of limited relevance: anything that helps us to understand this very complex system is valuable, but we must be cautious in overstating the scope – just because there isn't much data available, it doesn't mean that any data we have can be used to understand the whole system! Please see if you can adjust the narrative somewhat to satisfy these concerns (without requiring the full error analysis suggested by Reviewer 2), and also address the minor amendments below.

- We have added "... and is coherent with our small moulin likely connected to a low order subglacial channel." at the end of the abstract.
- Made the sentence more clear L66-67 that it is a small connected moulin "In this study, we investigate the hydrodynamics in the englacial-subglacial system of a small single moulin in a moulin-dense catchment using a single-conduit subglacial model coupled with the Moulin Shape (MouSh) englacial hydrology model."
- We modified the first sentence of the discussion to: "In this study, we provide the first comparison of modeled hydraulic head in a shape-evolving moulin to direct field measurements of a small subglacially connected moulin in Greenland.
- We modified the conclusion as suggested below

Abstract: please add 'small' as a preface to the moulin, or something else that flags that this is not a Greenland giant draining a large area, but part of a wider network of surface-subsurface connections.

#### **Added "small" in front of moulin**

Introduction: in lines 66-70, can you make it clear that this is a moulin-dense catchment and you are simulating just one small moulin that is likely part of a wider network

#### **Modified the sentence to:**

**"In this study, we investigate the hydrodynamics in the englacial-subglacial system of a single moulin in a moulin-dense catchment using a single-conduit subglacial model coupled with the Moulin Shape (MouSh) englacial hydrology model." L65-68**

Methods: please could you add more clarity on the  $Q_{in}$  modelling – your model output doesn't seem to capture the measured. You discuss some of the uncertainties associated with this, but I think a little more might be useful to address some of Reviewer 2's concerns. You add a little in L160-165, but I think more discussion of why the  $Q_{in}$  does not capture the full range of the measured  $Q$  would be beneficial.

**We reorganized the  $Q_{in}$  modeling section so that description of the model and limits are more separate. It seems that in the previous organization it was not clear where we were discussing limitation. We also clarified that the moulin - subglacial channel model is not sensitive to small variations of modeled meltwater input on a daily basis or small variations of peak. The Moush model output is sensitive to the multiday ratio between amplitude and mean discharge.**

L375 + L377: reference bracketing incorrect

#### **Fixed the parenthesis for both citations.**

L384: reference punctuation incorrect

**Removed the incorrect punctuation.**

L404-409: this seems like a really important point which helps to address the concerns of reviewer 2: your moulin is small, formed that year, and is relatively small. This means the behaviour you simulate is realistic, but only for this scenario of hydrology.

L446: slightly unclear meaning

**Changed the sentence to: “However, at our site, there is no surface crevasse passing through or close to the moulin ...”**

L558-9: this seems like a very large area feeding a very small stream and small moulin, especially given you note that there was a relatively high moulin density in the area. Please could you clarify whether this catchment feeds your single moulin, or whether it feeds the multiple streams and moulins in the region?

**Thanks for the comment. Since we are looking at the subglacial catchment potentially draining water connected to the moulin we are investigating, we included the area all the way up to the divide. This is why this is a large area. We’ve added text to emphasize that this is a SUBglacial area, not a SUPRAglacial area (where, indeed, 2000 km<sup>2</sup> would be very large).**

Conclusions:

L570: ‘Our results suggest that the moulins on the Greenland Ice Sheet require larger inputs than surface meltwater alone to keep their subglacial channels large enough to accommodate the observed wide diurnal range of surface input.’

The first line of the conclusion reads as if this moulin is representative of all moulins in Greenland, which you acknowledge in the paper and in your response that it is not. I would like the first sentence of the conclusions rephrased to better inform the reader of the applicability of your experiment.

**We modified the first sentence to be more specific towards our moulin, rather than generalizing to all moulins in Greenland: “Our results suggest that the moulin we instrumented requires larger inputs than surface meltwater alone to keep its subglacial channels large enough to accommodate the observed wide diurnal range of surface input.”**

Thank you for your submission to The Cryosphere and your patience in receiving these comments: I’ve had my head down a moulin in Greenland.

Dr Liz Bagshaw, Editor