The Cryosphere Discuss., 7, C2984–C2986, 2014
www.the-cryosphere-discuss.net/7/C2984/2014/

The Cryosphere Discussions
Open Access

Interactive comment on "Oscillatory subglacial drainage in the absence of surface melt" *by* C. Schoof et al.

Anonymous Referee #1

Received and published: 11 January 2014

Overview: Schoof et al present a nice combination of observations and modeling of subglacial hydrology at the end of the melt season on an alpine glacier. Relatively few measurements of subglacial hydrology have been made during the winter season due to the difficulty of maintaining equipment throughout the winter. The observation of periodic oscillations in borehole water level without obvious melt forcing is intriguing. The modeling approach, building on that of Schoof 2010, is able to reproduce important aspects of this behavior. This work improves our understanding of conditions at the beds of glaciers and ice sheets. The only major question I have is how the storage capacity of the boreholes influences the observations. With that minor revision, I recommend quick publication.

Main Points: Schoof et al. do a good job of describing a complicated data set clearly.

Many features are quite similar I hope that Figure 3 will be full-page width in the final version because much of what is discussed about the water levels is difficult to see in the figure.

I would like to see a discussion of the boreholes' storage capacity and influence on the observed variations. Is the storage capacity of the borehole large enough to influence the behavior of the subglacial hydrology system? This seems less likely during phase 1 when there is surface melt, but it could be critical during phase 4 when there is no melt. The slow rises and abrupt falls in water level for boreholes A2 and A3 is similar to observations on both South Cascade and Bench glaciers but no good mechanisms has been proposed for this type of behavior. A2 has more of these fluctuations than A3 although the two boreholes sometimes show synchronous drops despite different magnitudes. I wonder if the proximate cause of the drops is related to changes in an active channel/cavity system or if the drops are caused by isolated boreholes both affected by ice motion or some other non-direct hydrological forcing.

I am also curious if the two-day periodicity during Phase 1 (diurnal fluctuations) was observed in any other boreholes in other years. Of the $\sim$60 other boreholes drilled and instrumented, did this occur at any other sites or is it a relatively unique occurrence?

The question of the borehole storage capacity also affects the modeling. I had difficulty understanding the magnitude of the water input and storage terms in the model. I think a description of how the magnitude of the modeling inputs compare to expectations for South Glacier would be helpful. This may rule out the borehole as a storage component able to influence the subglacial hydrology system.

I also did not understand the justification for the lower boundary condition in the modeling. N (effective pressure) is set to 0 at the glacier snout. It seems like a more common boundary condition is that the water pressure is 0 (atmospheric pressure) which comes from the observation that most streams exiting a glacier have carved a tunnel that is not completely filled with water. This seems particularly likely at the end of the melt

TCD
7, C2984–C2986, 2014

season. Please describe why N=0 at the snout is the appropriate boundary condition or discuss the impact of the choice of lower boundary condition.

I also wonder how applicable this analysis is to the much thicker ice of Greenland and Antarctic outlet glaciers? With faster creep closure rates, does the system work the same except with larger water flux values? Or does the faster creep prevent either channels or cavities from being stable?

Specific comments: Subsections would be helpful in the interpretation and modeling section P5614, L6, “These” is ambiguous P5615, L20, delete “also” P5619, L22&23, do you mean “further” or “farther” P5619, L22, and “m” after 150 P5620,L5, is anything lost by plotting at 3 hour intervals? Seems like it might clip the falls in water during period 4. P5620,L15, Have you thought about plotting in height above some datum instead? You indicate that there are consistent offsets between boreholes. This could be sensor calibration, but it could also be differences in the bedrock elevation (borehole height) that if corrected might make the boreholes match. P5621,L21-23, “Initially, all three..” sentence is hard to follow. P5624,L18, this sentence makes is sound like you could re-calibrate but didn’t, but really its that you can’t get the transducer back P5625,L28, what effect does a new snow layer have in terms of reflecting solar energy and buffering surface melt water? P5628,L20, “channel-like” P5628,L25, delete “also” Figure 3: No need to subscript borehole names, A1 Figure 6: superscript values on x-axis; are the lower mL values realistic? Figure 9: superscript values on x-axis

---

Interactive comment on The Cryosphere Discuss., 7, 5613, 2013.