Review of Vatne and Irvine-Fynn 2015: Morphological dynamics of an englacial channel

1 Summary of manuscript (MS)

The MS presents a field mapping study of an englacial channel over a decade, to my knowledge, the longest such study. In the introduction it gives an overview of the literature and theories of both stream and ice-stream morphology and hydraulics. This is valuable as the audience of this paper may have backgrounds ranging from river morphology to glaciology. In the Discussion it advances sound qualitative explanations for the found morphological evolution.

The material is of high scientific value. However, the presentation needs polishing as outlined in the specific comments below. In particular, even though their results and discussion are sound, they often are presented in a somewhat confusing manner. After these shortcomings are cleared up, I recommend to publish it in HESS.

2 Comments

Page[1]	Line	Comment
16	13	In the Abstract better use "step" instead of "knickpoint" as that is less jargon.
	20	"37 m deep moulin shaft"
	22	"local hydraulic level" replace with "glacier bed"
18	27	The slope is not steepest at knickpoints but at the step riser, reformulate. The curvature however is largest.
19	16	These two points should be more prominently discussed in the Discussion or Conclusion or else made less prominent here.
19	21	I like Section 2 which gives an overview over the subject. However, it could be streamlined.
19	23	The first sentence of this paragraph needs rewording, the second maybe also.
22	6	I think this should read "knickzones" and not "knickpoints", as the points will not provide much flow resistance.
22	26	I think even with clastics, the meandering of supraglacial streams would be induced by helical flow. Thus this should be reworded.
23	2	Just write "cross-sectional area" and drop "width and depth".
23	8,11	I am very used to q being the water discharge in this context. Maybe use a different variable name? Or just combine the two into one equation and state that the numerator is the heat flux.
24	1-4	This is an awfully convoluted way to say that either of surface melt rate and stream incision rate can be larger.
24	15	I would cite Fountain and Walder (1998) here too.
24	18	replace "a more prominent" with "dominate" or maybe even "sole".
24	20	Drop "in the vertical dimension"
24	24	"at depth downstream" does not make sense to me.

[1] Add 7600 to the page number

Page	Line	Comment
24	26	Somewhere in this section the difference between pressurised and open channel flow should be made clear.
24	28	This sentence needs a better transition from the previous statements.
25	16	Long sentence.
27	1	That pool depth is inversely proportional to step height, probably needs a citation, as it seems quite counter intuitive to me.
27	7	This paragraph is confusing, it mixes up two things: cuspate forms and channel height. I didn't understand what was meant with cuspate forms until looking at Fig. 5. Maybe move this to the observation section?
28	29	I struggle with knickpoints being described as having an "extent", as a point has no extent. Also Fig.1 could suggest that the knickpoint is indeed a point. But I could well be wrong. Maybe use "step riser" in connection with extent?
29	1-5	Fig 4 talks about the "Type 1" and "Type 2" but they only get defined in the next section. This is a bit confusing.
29	15	"At the same time": maybe better "During the ..."
29	17	Again knickpoints having an extent, maybe use "step-riser"?
29	14	Entrance point B is never defined.
29	27-	Again struggling with the usage of "knickpoints" here. According to Fig.1 the whole assembly (pool + step-riser + knickpoint) is probably called a "step pool sequence".
30	2-4	This sentence needs reformulating. Also I'm unclear what the difference is between "step-riser and pool sequences" and a "knickzone".
31	6-8	Curvature and sinuosity are two different things with units of (1/m) and (). Thus the authors must be referring to sinuosity here, remove curvature.
31	12	Entrance point B is never defined.
31	22	It is confusing to end the last section with a statement that the discussion focuses on the longitudinal profile and not the plan form profile and then start the Discussion with the plan form one!
31-32	25-1	Why is this study of Myreng (2015) not just integrated into this paper and maybe Myreng made a co-author. The MS presents data from it in Fig.3 and discusses it several times. Considering this is a master thesis, presumably supervised by one of the authors, why not include it?
32	6	Now suddenly the discussion jumps to the vertical profile still within of what I thought was the plan-form discussion.
32	14	Is there any evidence that the crystallography of the ice impacts drainage morphology?
34	14-16	This is not about LG reaches and should be moved to a more appropriate place.
34	27	It is not clear what "wave-trains" are, either define them or reformulate.
35	15	Delete "have"
35	13-26	Mention again that meanders are a prevalent feature in MG.
37	1-19	Would it make sense to discuss MG reaches after LG and before KZ?
38	3	Define what is meant with "locally", probably a few channel diameters. As it stands now it seems to conflict with the next sentence which mentions "rate of heat loss" as something independent of local dissipation. If it is very local that rate of heat loss should be equal to the dissipation rate. But this is not the case here.

Page	Line	Comment
38	19-	This paragraph needs some work as it is repetitive and confusing.
38	28-29	Delete the second part of this sentence.
39	4	This sentence suggest that this makes the step riser shallower again. How shallow? What are the limiting factors?
39	9	This sentence misses something: what is the melt due to energy dissipation balanced against? Creep closure presumably.
39	25	A thought about Type 2 knickpoints: as they are vertical, recession rates should be quite small as contact of the jet is minimal. Maybe these evolve mostly by downward erosion of the pool/pool-overflow? The evolution could be like so: as a knickpoint migrates upstream it hits on the next upstream knickpoint. Its recession will stop, its face steepen to vertical. Finally, it can only erode downward until its upper pool reaches the level of its lower pool, i.e. it disappears.
40	10	Not clear. Is "bed surface surface water flow" correct?
40	16	Delete "published" as it is redundant. However, as the publication is not easily obtainable, maybe state the range of temperatures it found.
40	18	Just write "a conduit of radius r".
40	eq. 3	The treatment of this equation is wrong. The closure rate for a certain radius cannot just be used for any radius! The equation gives a closure rate dependent on the radius: $$\frac{\mathrm{d}r}{\mathrm{d}t} = -rA\left(\frac{\rho_i g h_i}{n}\right)^n \quad (1)$$ and can be solved for r as a function of time t for a given radius r_0 at $t = 0$: $$r(t) = r_0 e^{-A\left(\frac{\rho_i g h_i}{n}\right)^n t}. \quad (2)$$ These type of exponential decay laws are generally characterised by their half-life $t_{1/2}$, i.e. by the time it takes for the conduit radius to shrink to half its former size. The half-life is given by solving $r(t_{1/2})/r_0 = 1/2$: $$t_{1/2} = \frac{-\ln(1/2)}{A\left(\frac{\rho_i g h_i}{n}\right)^n}. \quad (3)$$ I get the following half-lifes for $h_1 = 80m$ and A values from the below referenced table: $T = 0C \rightarrow t_{1/2} = 0.7\,a$, $T = -5C \rightarrow t_{1/2} = 1.8\,a$ and $T = -10C \rightarrow t_{1/2} = 5\,a$. Therefore, for temperate ice a channel will close up over a winter to about 1/2 of its radius but at -5C it will be about still around 75%. The conclusions in this section have to be updated.
Fig 9.		Also, Figure 9 needs to present the data differently: maybe using the second of above equations to make a plot of h versus the % of closure over the typical length of a winter for the observed ice temperatures.
40	eq. 4	I would just use tabulated values of A, for instance from Cuffey and Paterson (2010) Table 3.4, page 75. This avoids having to deal with another equation and a lot of constants which does not add anything.

Page	Line	Comment
41	25	The abbreviation "AB" is not defined.
42	2-8	Long, confusing sentence.
42	15-17	Long, confusing sentence.
42	21-23	"time invariant equilibrium morphological features" contradicts the statement on p.73, l13 for MG reaches.
Tab 1		Give units for K_d.
Tab 2		State how the mean of channel width X_w is calculated: probably the mean over horizontal distance? Some of the "H %" and "V%" do not sum to 100%, presumably due to rounding errors. Correct.
Tab. 3		Give units of groove size measurements, presumably cm.
Fig. 1		V and H are not defined in the caption.
Fig. 3		Correct two spelling mistakes of x-axis label, move to bottom. Make y-axis from -90m to 0m. State that 2x vertically exaggerated. Then, a confusing feature, which should be explained in the text, is that the depth of the 2008 channel is deeper than the 2014 beyond 150m. Presumably the 2014 channel got more sinuous?
Fig. 9		The meaning of the legend is not explained. Maybe no need to cite Hagen et al. in the caption, this makes it seem like all of this is from them. (See also above for more corrections)

References

Cuffey, K. and Paterson, W. (2010). *The Physics of Glaciers*. Elsevier, Amsterdam, 4$^{\text{th}}$ edition.

Fountain, A. G. and Walder, J. S. (1998). Water flow through temperate glaciers. *Reviews of Geophysics*, 36(3):299–328.