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Interactive comment on "Laboratory observations on meltwater meandering rivulets on ice" *by* Roberto Fernández and Gary Parker

Anonymous Referee #2

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This manuscript is concerned with a laboratory study of meltwater flow over an icy surface, which is intended to be an analogue for supraglacial flows of glaciological relevance. The authors are primarily concerned with the morphology of spontaneously incised drainage pathways arising in their experiments, which they compare quantitatively to similar morphologies observed in fluvial environments, finding many similarities. Then the authors go on to discussing how their mm-to-cm scale laboratory patterns differ from the much larger scale natural supraglacial channels, and argue that despite the difference in scale, their laboratory channels can be considered good proxies for the supraglacial ones, and therefore the insight obtained by comparison with the fluvial setting can be extended supraglacial meanders.

While the paper is nicely written, the data presented appear to be carefully analyzed,

and great care is taken to compare laboratory observations to datasets of fluvial morphologies, in my view the relevance of this work to supraglacial channels remains marginal. Besides some relatively minor comments on the Introduction (see minor points below), there are two key aspects of the experimental setup that motivate my point of view: the laminar regime, and the very warm (up to 21 deg C at the inflow, not kept constant over the course of each experiment, as per table 2) water temperature. Both these aspects affect the energy balance of the flow in ways that make hard for me to believe that any similarity may exist with the supraglacial setting: there meltwater is originated by melting of snow/ice, and is therefore very close to the melting point temperature (if not overcooled), so having enough energy available for melting comes down to turbulent heat dissipation in the flow. This is a very different configuration from the one studied in the laboratiry, where all the energy is supplied by the very warm water (which, incidentally, cools down by over 10 deg between inflow and outflow, demonstrating my point), with internal heating being negligible due the laminar regime. In light of this, unsteadiness in the inflow temperature (see table 2) may be significant in driving the meandering instability, and perhaps in producing some of the observed features. This should be at least acknowledged in the manuscript, and possibly elaborated on.

To counter my main criticism above, I encourage the authors to consider carefully these thermal aspects in their Discussion section, which I would recommend to rewrite with increased focus on the supraglacial (rather than fluvial) setting. Why did you choos water temperature to be this warm? Does it have any effect on the morphology? How does it compare to natural supraglacial setting? Can you tell us anything about heat fluxes at the ice water interface? These are all questions glaciologically inclined readers would want to see adreessed. At the moment, the applicability of this study to supraglacial streams comes across as an after thought. I believe that, upon a thorough revision, this paper may become as relevant to the glaciological community as is already to the fluvial morphology one, hence I would encourage the authors to pursue this angle at depth.

Minor points:

1) Introduction: I am not sure about what is special about the satellite image from the Petermann glacier brough as a motivation. There have been a number of similar observations of surface melt lately, in similarly or even more unexpected places (a good starting point for a literature review would be Kingslake et al. 2017, https://doi.org/10.1038/nature22049), which all show similar morphologies. As written, the paper suggests that the Petermann iceberg is somewhat special, which I think is deceiving.

More broadly, I find that the glaciological motivation (and literature) provided in the introduction is rather scant. At present, modelling glacier surface hydrology (beyond water routing models) remains very challenging for ice sheet modellers, mostly because the physics governing the topology of the network are not quite clear yet and hard to model. Experimental work can help constrain those physics, so why not to mention this aspect as well in your introduction?

2) Page 2, line 18: define supercritical and subcritical flow conditions

3) Page 3, line 14: what is a periodontal probe?

4) page 4, line 19: " direction spatial series was .." there is something wrong with the text here, please check

5) Page 12, lines 26-27: I am not sure why increased meltwater discharge due to climate warming should make these channels more relevant. Are the authors hinting at any particular physical process?

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