## *Interactive comment on* "Multi-modal sensing drifters as a tool for repeatable glacial hydrology flow path measurements" *by* Andreas Alexander et al.

**Elizabeth Bagshaw (Referee)**

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This paper gives a comprehensive account of a challenging experiment to assess the repeatability and usability of data collected by a drifting sensor. It should be noted that experiments including field testing of new engineering techniques in extreme environments are exceptionally challenging, and the authors should be congratulated on their successful deployment. The paper is well-written, and gives a comprehensive review of much of the supporting literature.

However, the scope of the paper is somewhat confusing to the reader, since the problem is framed as a subglacial experiment, yet the data are confined to the supraglacial

environment. This in no way invalidates the results, but I believe that the paper would be more appealing to the target audience if the supraglacial scope were made clear from the first paragraph and in the abstract. The subglacial deployment may be the ultimate goal of the project, but the current state of the science and engineering is limited to the supraglacial. I advise that the introductory paragraphs and abstract are focussed on supraglacial literature, with some additional references as necessary (for example, Decaux et al 2019 cited later). The subglacial material can then be moved to later in the discussion, to make clear how the supraglacial results can be utilised and developed in the future.

I like the use of statistics to validate the sensor performance, and the realism in relating the statistical results to logistical practicality. However, the actual purpose of the paper is not entirely clear in this iteration – is it an engineering test, a sensor validation exercise, or does it reveal a previously unknown glaciological phenomenon? All of these are valid outcomes, but the introduction and particularly the abstract should be better focused to demonstrate that experimental purpose to the reader. The paper could also be shortened by moving some of the tables to supplementary info (see below).

Specific comments Figure 1: please could you include a labelled photo of the sensors? It would be great to see them in a bit more detail Figure 2: Place names are illegible on the map, and the features of the glacier need some labels in c). It would be useful to know where the net was situated, for example, and perhaps have some accompanying photos of the deployment/recovery sites Could you comment on the feasibility of the net recovery in a larger system, and if the sensors are destined for the subglacial system, on the robustness of the net methods with debris and bedload transport in the flow? Table 1: Could transmission distance (if relevant) be a separate column rather than a comment? P3, L23: Is 500 Euro truly low cost?! This is a subjective term. P10, L20: Please include an estimate of the range of discharge variability Figure 3 doesn't really add much to the paper, it could be removed to save space without detriment, since the workflow is not unusual and is described in the text P12, L25: please define the

'features of subglacial channels' Figure 4 and Tables 3 and 5 may be better placed in supplementary info, since their content is only of interest to a very specific audience and the paper is rather long Table 4 and P14, L7: what is the 'required size' for a subglacial deployment? Unclear how these measurements are extrapolated to the subglacial system: just because the drifter can move through an open supraglacial stream doesn't necessarily infer that it will pass through the subglacial environment Figure 10: Can other sensor data be added to this figure? It would be very useful to see the accelerometer data plotted alongside. The IMU accelerometer method is really exciting, so if the data could be demonstrated alongside the pressure and photographs, it would really contribute something valuable to the field. P25, L11-25: What were you hoping to determine with this dataset? It seems that you have proven that the technology and the sensor set work (which is great!), so can you relate this to the flowpaths? How do the data relate to visual observations? If you hope to use this to visualise subglacial systems, then it is important to relate the sensor data (of which you have a considerable quantity) from the supraglacial system to visual observations where you can. Then you can demonstrate how this might be used in the subglacial environment. 'We need more data' seems a bit of a cop-out! What precision do you need to obtain scientifically useful data? P26, L26: What is 'satisfactory performance'? This is very subjective. What did this experiment hope to achieve, and did you do it? Was it field testing of the casing, the transport method, or of the sensor performance, or of the usefulness of the data to characterise the supraglacial flowpath? Or of future subglacial deployment? Please be specific – this is an excellent engineering test, but subjectivity in appraisal should be avoided. Table 6 isn't terribly useful.