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The Cryosphere Discussions
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Interactive comment on "Combined diurnal variations of discharge and hydrochemistry of the Isunnguata Sermia outlet of the Greenland Ice Sheet give in sight on sub glacial conditions" *by* J. Graly et al.

Anonymous Referee #1

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General overview

This is an interesting study looking at the temporal variation in the hydrochemistry of a sizeable glacial catchment in SW Greenland. On the downside, there is relatively little data – only four days of coupled relative discharge and chemical composition data, with no absolute discharge data. To be fair, this is clearly a logistically challenging site to work in, with no fixed points to allow reliable continuous data logger monitoring, and even limited robust time series data from such a large catchment is worthwhile. This paper is building on their recent Geology paper 'Chemical weathering under the

Greenland Ice Sheet', which examined the bulk chemistry of a series of boreholes waters across the catchment.

The authors do a commendable job of attempting to maximize the interpretation of the limited data set through the use of time lapse photography. The principal conclusion is that there is a phase shift between relative discharge and solute concentration, perhaps best explained by the expansion of a distributed subglacial hydrologic network into seldom accessed regions during high flow. This conclusion appears intuitively reasonable, although I have some reservations that need to be addressed. My key concern is whether the relative discharge measurements are robust enough given relatively poorly constrained potential variations in water depth and water velocity (see major points below).

Major specific points

Lines 159-162 – you base one of your major conclusions on the assumption that the width of the active channel is proportional to discharge. This is based on the assumptions that a) water velocity doesn't change, and b) water depth doesn't change (line 204). I have the following concerns/questions with this approach:

a) You state that your velocity measurements were measured only in the first two days only of the sampling period – from reading the methods, this would appear to be a period when you didn't assess discharge through photography. Since you do not have paired velocity (from surface object movement)-relative discharge measurements (from photography), how can you be sure that your conclusion that velocity does not change during the crucial last 4 day period of study is robust? (line 204; a critical underlying assumption for assuming active channel width is proportional to relative discharge). Particularly as the initial 2 day period was when the naled was completely covered in water hence discharge likely anomalously higher than remainder of study (or bedload sediment depth higher).

b) Line 159-162 – you need to give more details of your methods here. How many

repeats of surface velocity measurements were made? From results you state 6 total measurements? (this doesn't seem a lot to base your conclusions on over the whole period of study). What were the 'other objects' in the water that you use as velocity indicators? I'd also question the validity of using ice blocks as reliable relative velocity indicators – could they not become snagged by debris in river, or velocity altered by differences in wind direction and speed, position in channel etc? You also need to state that the cross sectional normalized flow rate is likely to be substantially different from the surface velocity, particularly when using non neutrally buoyant objects.

c) You also state there is no change in depth in the river, although you also state that there is considerable mobility of sediment with collapsing banks, and scouring and deposition of sediment. Surely the assumption of constant river depth (line 204) should be viewed as a guestimate?

Line 299-301 – given the large uncertainties in relative discharge measurements (see above), I don't think you can make a quantitative statement that the discharge variation is substantially larger than the variation in concentration of dissolved solutes – though fair to say that the likely width of the active channel roughly doubles.

Other specific/technical points

Line 8 – would be more correct to state that there are 4 days of continuous relative discharge and hydrochemical data

Line 11/12 – don't need to state that element and ions were measured in lab in abstract (plus you also measured suspended sed weights in lab, and

Line 17/18 – I'd omit this sentence from abstract – it is based on the prior season's discharge from a single supraglacial stream. Worth mentioning in main text, but not strong enough for abstract.

Line 56 – would be worth referencing Wadham et al Global Biogeoch Cycl 'Size Matters' article here

Line 93 – need to either reference this subjective number of 500 m3s-1 to something (visually, similar to observed discharge at x, which has a discharge of x) or omit.

Line 110 – what kind of bottle, Nalgene PP?, was it cleaned, rinsed with sample etc? how long was pole?

Line 120 – 0.1 um nylon filters seem an odd choice – most studies use 0.2 um or 0.45 um, why were these chosen? What filtration apparatus was used, Nalgene? Were procedural blanks (e.g. using MQ water) carried out, what were these blank values and how did they compare to instrument detection limits?

Line 126 – pH is always tough to accurately measure in low conductivity glacial waters. Please give further details – was 2 or 3 point calibration used, how long was pH probe left to stabilize prior to reading? Two decimal points for pH in Table 1 seems v optimistic.

Line 128 – please state precisions and detection limits here, ditto line 130

Line 130 – what temp were filters dried, and for how long?

Line 176 – typo, should be gauge

Line 176 to 178. What was the comparative weather like during the 6 day main study water sampling? To what depth into ice interior had snow line retreated to during both seasons – the outlet has a large catchment, and snow cover will have a major impact on the timing/magnitude of discharge runoff.

Line 182 – you start with discharge results. You should ideally be consistent with the order of methods section – perhaps best to start methods with discharge.

Line 200 – you need to put in these calculations, and state assumptions

Line 240 – how were lab TDS calculated: from summing inorganic ions, or by measurement using conductivity/TDS meter?

Line 343 – should put relative discharge, not just discharge – also see major points

above

Line 343 – you only measured relative discharge over 6 days, not four

Line 344-347 – given many uncertainties in measuring relative discharge, I think this statement is too strong

Table 1 – there are too many decimal points – I would have thought one decimal point is sufficient for most (though need to compare to precision of analyses). Also, need to put charges on anions to be consistent with main text. Plus better to have field alkalinity and calculated alkalinity in adjacent columns to aid comparison.

Figure 2 – these were too small in my printed copy to see properly. Please make photos larger, they are a key component of the study

Figure 3 – Rather than having smoothed lines for min/max discharge, put on hourly points (or as well)

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